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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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Development of WATER RESOURCES in APPALACHIA

MAIN REPORT
PART III
PROJECT ANALYSES
CHAPTERS 14 thru 16

WHITEOAK RES.
LOGAN RES.
MIDLAND L.P.P.

OFFICE OF APPALACHIAN STUDIES

CORPS OF ENGINEERS

U. S. ARMY

DEPARTMENT OF THE ARMY
OFFICE OF APPALACHIAN STUDIES. CORPS OF ENGINEERS
P. O. BOX 1159
CINCINNATI, OHIO 45201

IN REPLY REFER TO

TO: THE READER

This volume ~~(Number 10)~~ is one of six that comprise Part III, "Project Analyses", to the Main Report for Development of Water Resources in Appalachia. The volume contains three of the 20 chapters that make up Part III.

Each chapter generally contains information on how the project was formulated and designed; its estimated costs; the type and value of benefits expected; and the indices of performance. Also included, as appropriate, is information on sharing of project costs among Federal and non-Federal interests, coordination carried out during the planning process, and conclusions reached.

Chapters 14 and 15 were prepared by the U. S. Army Engineer District, Huntington. Chapter 14, Whiteoak Dam and Reservoir Project, presents a plan for a multiple purpose reservoir development on Whiteoak Creek, 40 miles southeast of Cincinnati, Ohio. Chapter 15, Logan Dam and Reservoir Project, presents a plan for a multiple purpose reservoir development on Clear Creek, 30 miles southeast of Columbus, Ohio. Chapter 16, Midland Local Protection Project, prepared by the U.S. Army Engineer District, Louisville, presents a plan for a local protection project for Midland, Kentucky (a potential "new town") which will enable the community to realize the full potential of a designed urban service center development.

The Summary Report (Part 1, Volume 1) should be consulted for recommendations made as a result of the information presented in this volume. A volume index for the Main Report and its nine supporting Appendices is included on the next two pages for your convenience.

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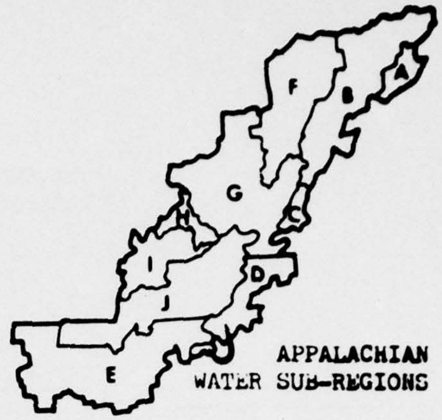
Colonel, Corps of Engineers
Director

REPORT
For
DEVELOPMENT OF WATER
RESOURCES IN APPALACHIA

VOLUME INDEX



APPALACHIAN
WATER SUB-REGIONS

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REPORT
For
DEVELOPMENT FOR WATER
RESOURCES IN APPALACHIA

VOLUME INDEX

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

Main Report.

Part III. Volume 10.

PART III - PROJECT ANALYSES

VOLUME 10

CHAPTERS 14 thru 16.

14. WHITEOAK RESERVOIR, OHIO

15. LOGAN RESERVOIR, OHIO

16. MIDLAND LOCAL PROTECTION PROJECT, KENTUCKY

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November 1969

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 14

WHITEOAK DAM & RESERVOIR PROJECT

WHITEOAK CREEK BASIN, OHIO

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August 1969

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PART III

PROJECT ANALYSES

CHAPTER 14 - WHITEOAK DAM AND RESERVOIR PROJECT

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CHAPTER 14 - WHITEOAK DAM AND RESERVOIR PROJECT

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PART III

PROJECT ANALYSES

CHAPTER 14 WHITEOAK DAM AND RESERVOIR PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

The Whiteoak multiple purpose reservoir site is located in the Central Lowland Province in southwestern Ohio about 40 miles southeast of downtown Cincinnati. It is entirely within Brown County, Ohio. The project, with a 200-foot high dam located 9.8 miles up Whiteoak Creek, would control 214 square miles of drainage area which is about 91 percent of the basin's total drainage area of 234.3 square miles. The location is shown on Exhibit 14-1.

Major physical features of the project would be the 1,650-foot long earth fill dam; an uncontrolled, broad-crested, 500-foot spillway; and outlet works consisting of a wet type intake structure controlled by multiple level gate openings. The reservoir would have a total storage capacity of 78,200 acre-feet equivalent to 6.8 inches of runoff from the contributing drainage area. Associated with the reservoir project would be an Environmental Resources Development Plan comprising three basic components:

a. An inviolate migratory goose refuge,
b. Adjacent managed hunting lands, and
c. A highly developed general recreation park around the recreation lake

The general recreation portion of the plan also incorporates features to be used jointly by fishermen, especially in the tailwater area below the dam.

2. PROJECT IMPACTS

The overall economic development plan for the Whiteoak Creek Basin and Brown County includes the water resources project and the associated development necessary to complement the water project and achieve the bench mark objectives. The plan of development for the water project has been prepared with a view to providing for optimum utilization of the project land and water areas available outside the refuge. The reservoir project would provide the goods and services needed to satisfy the water related needs of the area including such specific benefits as:

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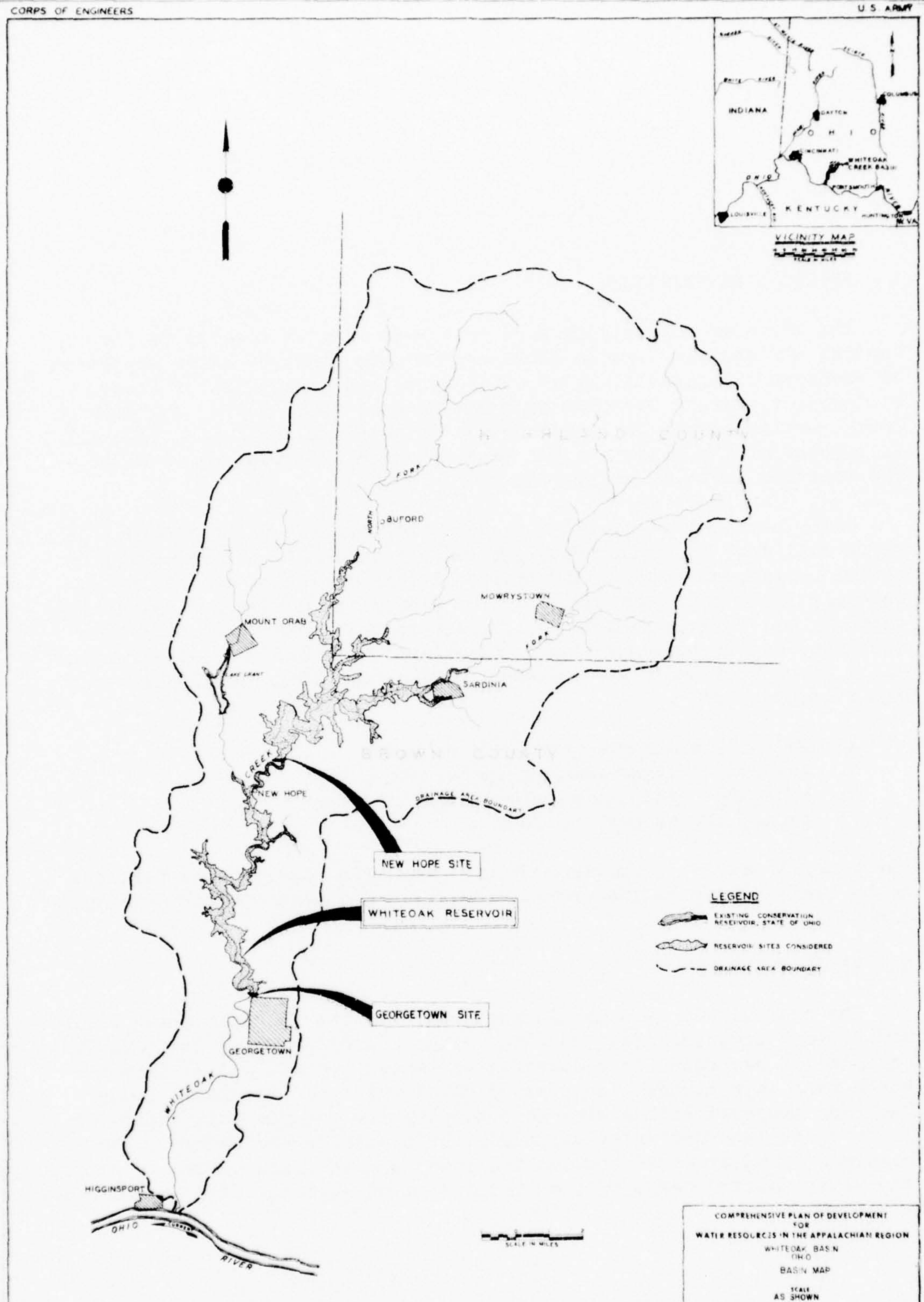


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
WHITEOAK BASIN
OHIO
BASIN MAP
SCALE
AS SHOWN

a. Water supply
b. Outdoor recreation
c. Flood damage reduction
d. Water quality control
e. Fish and wildlife enhancement including migratory goose refuge
f. Economic development

Past and current studies of the water and allied resources of the area have identified one important, and perhaps the most significant, detrimental factor to the marginal economic progress of Brown County and the surrounding area - the severe limitation of readily available surface and ground water supply. Senate Resolution adopted 10 September 1957, and House Resolution adopted 1 July 1958, requesting the survey scope study, emphasize the water supply aspect of the water resources problem. The water supply and water quality control functions of the reservoir project would meet the total demands for those functions with the industrial development plan in effect through the year 2075. The flood control function would reduce flood damages along the Ohio River by $257,300 annually. Recreation opportunities would be provided for about one million visitors annually including hunters, fishermen, picnickers, campers, swimmers, boaters, sightseers, photographers and naturalists. The establishment of the major migratory goose refuge and managed hunting area would offer the recreation visitor a unique experience. A comprehensive interpretive program is planned with guided tours, show ponds, and observation tower and nature trails. The wildlife resource of the proposed plan will contribute to the National Migratory Bird Management Program by providing a "stepping-stone" in the long-established concept of migratory bird flyway management. The Whiteoak Creek site is between a major waterfowl flyway crossing southeastern Ohio and a minor flyway crossing central Ohio.

The initial construction expenditures for the water project and annual operation and maintenance expenditures would insert new income into the area during the early stages of development. Later, as industry and allied developments are induced into the area, new income will be provided through wages, local profits and successful rounds of spending money. With the industrial development plan in effect, some 14,000 new job opportunities are expected to be created by 2020 which would be directly attributable to the plan. The industrial development plan is described in Exhibit 14-31.

3. COSTS AND BENEFITS

Costs for constructing the Whiteoak Dam and Reservoir project with the refuge are estimated to be $40 million; annual economic charges are estimated at $1,873,700. Comparable values for the associated development plan are $445.6 million with an annual equivalent of $15.2 million. Annual benefits for the water project and development plan are estimated as follows:

	Benefits	
	National	Regional
User	$ 2,093,000	$ 821,000
Expansion Effects		
Redevelopment	106,000	281,000
Development	11,901,000	88,578,000 1/

1/ Does not include $13,914,000 return on investment.

Using the preceding, the index of performance would be 1.2 for the objective of increasing national income and 5.2 for increasing regional income. (See Section VI).

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accord with present Federal policy, costs allocated to flood control and water quality control would be apportioned to the Federal Government. Non-Federal interests have been apportioned all construction costs allocated to water supply. Separable construction costs allocated to recreation and fish and wildlife enhancement would be apportioned equally between Federal and non-Federal interests, with one exception: Costs incurred specifically for the purchase of lands for migratory waterfowl refuge uses in connection with an authorized Federal program shall be considered non-reimbursable in accordance with sub-Section 6(e) of the Federal Water Project Recreation Act of 1965 (PL 89-72). The Director of the Department of Natural Resources, State of Ohio, has indicated the State's intent to provide all necessary assurances required for both the water supply and recreation functions of the Whiteoak Dam and Reservoir. In his capacity as the Governor's designated representative in matters dealing with the Corps of Engineers, the Director also indicated the State's intent to provide full cooperation in assuring that the proper and necessary developmental efforts would be made toward realization of the objectives of the overall economic development plan.

Prior to construction, non-Federal interests should provide assurances that they will protect the channel downstream from the reservoir from encroachment which would adversely affect operation of the project; contribute to the control of pollution of streams subject to low-flow augmentation by requiring adequate treatment or other methods of controlling wastes at the source; and exercise, to the full extent of their legal capability, control against removal of stream flow made available for water quality control.

SECTION II - PROJECT FORMULATION

5. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

Introduction. The needs which could be met by development of land and related water resources of the Whiteoak Creek Basin are discussed briefly in the following paragraphs. During the public hearing held in 1968, local interests expressed a major concern for the economic redevelopment of the basin and for the development of adequate water supply for both urban and rural use.

Consideration of the potential Whiteoak Reservoir for multiple purpose development indicated that a large, dependable source of water supply could be provided, thereby increasing the prospect for economic growth. The developmental study included a survey of the present economic environment of Brown County to establish that there is a significant potential for future growth sufficient to achieve full realization of the objectives of the Appalachian Regional Development Act by the year 2020. Specifically, the study objective was to determine the optimum plan or plans of development which would be most responsive to the Appalachian Regional Development Act and to the outstanding resolutions when subjected to both National and regional efficiency criteria.

The basic developmental study procedures included an assessment of the past and present economic indicators for Brown County and an analysis of the significant impediments to growth. Developmental benchmark levels of economic activity established for Appalachian Sub-regions were used to develop long-range projections of the basic economic indicators. The projections were used to quantify physical resources needs and public and private investment necessary to support the benchmark level of economic activity. The income growth deriving from the public and private investment in the form of wages and profit was claimed as the benefit ascribable to the development. Two sets of projections were prepared so that future levels of development could be determined both with and without the developmental plan. The difference in the projected levels would reflect the growth induced by the plan. A more detailed discussion of the present and projected economy of Brown County and the impact area is presented in Exhibit 14-30. The water project was scoped to insure that the physical demands of the induced growth could be satisfied. Final formulation of the optimum plan for the water project was based not only on providing functions evolving from the developmental plan but also on providing other water and water related functions not directly associated with the developmental plan and not directly necessary for its realization. These other functions which are equally important from both the National and regional perspective, would include general recreation, fish and wildlife enhancement, and flood control.

The role of water resources in the economic development of Brown County. Brown County is rural in nature. Eighty-nine percent of its 1966 population of 27,000 was classified as rural. The county's population, even though it has increased in recent years, has not kept pace with National population growth. In 1966, the labor force of Brown County was 8,700 with 5.7 percent or approximately 500 persons unemployed. The area has a surplus of labor caused by underemployment in agriculture and low participation rates, especially for females. About 2,100 persons were employed in agriculture in 1960. The largest source of employment, other than agriculture, is manufacturing which had slightly less than 2,100 employees in 1960. Significant numbers of workers commute to the Cincinnati area. In 1962, the county's per capita income (1954 dollars) was $1,380, which is considerably less than the State and National figures. Value added by manufacturing has decreased in recent years.

The existing pattern of slow growth with income and employment well below the state average will probably continue unless efforts are made to stimulate economic growth. Increased growth through industrial expansion could not be accommodated with the limited water supply sources now developed. Ground water supplies are so limited that significant further development of sub-surface sources would be extremely difficult. Although the industrial base is small and opportunities for local employment are presently limited, there is a large amount of relatively flat land available for industry and commerce and an excellent transportation network. The prime industrial sites (which may be pre-empted for non-industrial purposes unless protective measures are taken) are presently undeveloped farm lands lying between the Norfolk and Western Railway and State Route 32 and between the railroad and the proposed Appalachian Corridor D highway. (See Exhibit 14-31.) Consideration of these and all other factors contributing to economic growth potential clearly pointed to the lack of adequate water supplies as the primary physical restraint, if not the only restraint, to economic growth. The restraint to economic growth in Brown County encountered in the lack of dependable water supply sources reveals the direct role water resources development can play in economic development. In Brown County, economic growth would not be dependent on other phases of water resources development although development of water oriented recreation facilities and provision of stream flow augmentation for water quality control would enhance community amenities, thereby indirectly influencing economic growth. Additionally, the provision of a water project to meet all assessed user needs would have an immediate redevelopment impact on the area's economy deriving from the use of unemployed or underemployed resources in the construction, operation and maintenance of the project.

Water supply deficiencies. About 60 percent of the Whiteoak Creek Basin has inadequate ground water supply, with wells generally yielding less than 5 gallons per minute (gpm). Generally, water wells must be supplemented by cisterns to provide an adequate domestic water

supply. The northwestern portion of the basin has slightly more abundant ground water and wells can produce yields of 5 to 25 gpm.

The larger upstream communities in the basin utilize water supply from Whiteoak Creek or its tributaries in conjunction with off-stream storage reservoirs. The Federal Water Pollution Control Administration (FWPCA) concluded from their studies that under conditions to exist with the development plan in effect, the communities of Georgetown, Mount Orab, Sardinia and Mowrystown will require additional sources of water by 1975 and will need a daily supply of 2.08 and 3.20 million gallons in the years 2000 and 2020, respectively. The present rate of consumption is about 0.35 million gallons per day (mgd). Also, by 1975, the present water treatment plants will need to be enlarged and modernized. The FWPCA also estimated that the entire Whiteoak Basin, including essentially all of Brown County and the southwestern quadrant of Highland County, would require water supplies of 6.40 and 7.90 mgd by the years 2000 and 2020, respectively. By means of a simple straight line projection, the water supply requirement for the area is estimated to be at least 16.5 mgd by the year 2075, the end of the water project's economic life.

Maintenance of stream quality. The streams in the Whiteoak Basin, as in the other basin, carry away the municipal and industrial wastes. Georgetown and Mt. Orab are the only communities in the basin having municipal sewage treatment plants. The impervious Illinoian soil found in the basin makes home sewage disposal systems extremely difficult to construct properly. As the area develops it will become imperative for all communities and built-up areas to provide adequate treatment for their waste in order to maintain adequate water quality in Whiteoak Creek. The FWPCA (in Appendix D) estimates that minimum stream flow requirements would reach 4.7 and 7.0 cubic feet per second (c.f.s.) by the years 2000 and 2020, respectively, in order to maintain a desirable stream quality having a dissolved oxygen content of at least 4.0 milligrams per liter. A straight line extension of these projections results in a total demand of 14.3 c.f.s. by 2075. These minimum streamflow requirements would be in addition to waste water flows discharging into Whiteoak Creek below the Whiteoak Reservoir. FWPCA also stated that with proper operation the volume of waste water from Sardiana and Mount Orab should not create a nuisance in the reservoir.

Water damage prevention. Due to the characteristics of the stream banks and the general topography of the area, flood damages to improvements in the Whiteoak Creek Basin are very minor. Most towns in the basin, though located near the streams, occupy fairly high ground. Agricultural damages occur primarily in the headwater areas. The magnitude of flood damages and trends of development along the Ohio River below the mouth of Whiteoak Creek are important to this study since the damages which could be prevented would have a significant bearing on the economics of projects considered. Detailed flood damage surveys of the entire Ohio River valley have

been made, starting in 1937, and updated periodically, as necessary to incorporate damages to new developments. New surveys are under way and the completed portions were utilized for deriving benefits attributable to the projects considered herein. As of January 1968 there were 50 completed Corps of Engineers flood control and/or multiple purpose reservoirs and 21 under construction within the Ohio River Basin that reduce flood stages in the reaches of the Ohio River affected by the potential Whiteoak Reservoir. Of these, 37 of the completed reservoirs and ten of the reservoirs under construction are located on tributaries of the Ohio River upstream from the mouth of Whiteoak Creek.

Needs for recreational facilities in the Whiteoak Creek Basin. The problems and conditions relative to the National need for recreational opportunities are similar to the problems and conditions existing in and adjacent to the Whiteoak Creek Basin. The imbalance in recreation opportunities available within the area is indicated by the fact that the few existing recreational developments are being utilized to nearly their full capacity. The U. S. Fish and Wildlife Service finds that there is a scarcity of high quality ponds or impoundments available for public usage, and a serious lack of upland game public hunting lands.

Studies for recreation development of the Whiteoak Creek Basin require consideration of the problems and needs not only within the basin but also within extensive areas beyond the immediate watershed which would be influenced by such development. The Bureau of Outdoor Recreation recognized the recreation market area as including the 14 counties within an hour's driving time of the reservoir as well as an appropriate portion of the several Standard Metropolitan Statistical Areas located between one and 2.5 hour's driving time of the reservoir. It is estimated that the demand for outdoor recreation opportunities within the zone of influence will exceed the existing and planned capacities by 78 million recreation or visitor days by the year 2020.

Wildlife resources management and needs. The Bureau of Sport Fisheries and Wildlife (BSF&W) studied the proposed project in cooperation with the Division of Wildlife of the Ohio Department of Natural Resources, the Bureau of Outdoor Recreation and the Huntington District of the Corps of Engineers. In concert with, and at the request of the Ohio Department of Natural Resources, the BSF&W recommends that a wildlife management unit be established adjacent to the Whiteoak Dam and Reservoir, with management given primarily to Canada geese. The unit would serve as a wildlife refuge and controlled public hunting area. By providing intermediate sanctuary and food to migrating waterfowl, the unit would contribute to the preservation and expansion of the waterfowl resource. The BSF&W concludes from its studies reported on in Appendix G that "fully one-third of Ohio's waterfowl hunters dwell in southern Ohio and there are as yet no significant acreages

of public-owned waterfowl management areas provided for them." The major portion of the management area would be designated as an inviolate goose refuge with the remaining acreage devoted to food production, controlled hunting, and wildlife-associated uses.

6. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

General. Inventory of the Whiteoak Creek Basin for potential reservoir sites disclosed that only on the main stem of Whiteoak Creek were there sites having sufficient storage capacity for flood control, water quality control and water supply combined. These sites would provide control of considerably more drainage area, thereby increasing the flood control capability and the recharge capability for water supply and water quality control. Field reconnaissance and preliminary design studies for specific dam sites limited the choice of reservoir sites to one multiple purpose project site at Georgetown and one limited multiple or single purpose project site near New Hope.

Developable water supply sources. There are five basic alternative schemes for developing future water supply sources for Brown County: (1) construction of a system of off-stream reservoirs and small tributary reservoirs; (2) construction of major main stem reservoirs which would be primarily for water supply; (3) pumping from the Ohio River; (4) pumping from East Fork Reservoir which will soon be in operation in the East Fork of Little Miami River watershed; and (5) provision of water supply storage in a multiple purpose reservoir on the main stem of Whiteoak Creek. For long range needs, neither a system of small tributary reservoirs nor the East Fork Reservoir would be physically feasible. The limited supplies which could be provided from these sources would require the development of one of the other three sources within 15 to 20 years. Should either a main stem single purpose or multiple purpose reservoir be developed at that time, such a reservoir would have a large amount of storage primarily for future needs. Since a portion of the reservoir storage could have been used to satisfy all current demands, local interests would be incurring much greater costs than they would have if the large reservoir had been constructed initially. It is conceivable that Brown County could draw on the East Fork Reservoir until about 2000. At that time, all of the storage in the East Fork Reservoir would be required to meet demands in the East Fork Basin and Clermont County. Then a reservoir could be built on Whiteoak Creek to serve Brown County after the year 2000. However, the initial cost of constructing pumping plants and pipelines from East Fork Reservoir to centers of population in Brown County would be roughly equivalent to the initial cost of providing water supply in a multiple purpose Whiteoak reservoir. The present extremely high cost of water service in Clermont County (minimum charge $7.00 per month) and the probability of demands increasing ten-fold by the year 2020 indicate that the East Fork Reservoir is the most logical source to satisfy those demands.

It is considered that water should not be exported from Clermont County while local residents are incurring the high cost of extracting water from the Ohio River.

Using the Ohio River as the source of supply for Brown County would involve not only the high initial cost for a pumping station and ten miles of pipeline to the principal distribution center, but also extremely high annual pumping costs. The total head disadvantage between the Ohio River and the average water supply pool elevation at Whiteoak Reservoir is 315 feet. Also, utilizing the Ohio River as a water supply source would adversely affect the quality of Ohio River water. Water withdrawn from the Ohio River would be returned with pollutants. Multiple purpose reservoirs on Ohio River tributaries in this area could furnish water for supply and for stream augmentation, thereby improving water quality in the Ohio River in a critical reach just above Cincinnati.

For comparison purposes, the minimum costs for pumping from East Fork Reservoir and the Ohio River, respectively, have been estimated at $290,000 annually and $266,000 annually over a 100 year project economic life. The cost of a single purpose structure on Whiteoak Creek (New Hope site) would be $216,100 annually. This alternative is considered to be the least expensive as well as the most practical alternative available in lieu of a multiple purpose structure.

Potential water quality solutions. Flow regulations for quality control can be provided only by a major reservoir upstream from Georgetown. The minimum stream flow requirements as estimated by the FWPCA assume that adequate secondary treatment (85 percent removal of biochemical oxygen demand) will be provided by the community of Georgetown. Future demands for water supply in excess of those projected could make it imperative that tertiary sewage treatment be provided in lieu of augmenting releases in order to adhere to quality standards. The possibility is not remote that demands for water could increase substantially beyond those projected for Brown County.

Non-structural alternatives for flood damage prevention. Because of the minor magnitude of flood damages along Whiteoak Creek, non-structural alternatives for prevention of damages were not considered. The flood control function of the proposed project would effect prevention of damages primarily along the Ohio River. The extensive damages to existing improvements incurred along the Ohio River would indicate that the best solution to the problem would incorporate both structural and non-structural measures. Consideration of any measures to be applied outside the Whiteoak Creek Basin is beyond the scope of this report.

Migratory goose refuge. The refuge would require some 7,500 acres of land including 4,100 acres of land which otherwise would be used for general recreation and joint-use purposes. The refuge would utilize the northernmost 184 acres of the seasonal pool. No fishing

or general recreation activities would be permitted on this portion of the lake or elsewhere within the refuge. The recreation function of the reservoir would be drastically modified. Preliminary estimates of additional land and development costs and revisions of the costs and benefits attributable to the modified recreation plan indicated that incorporating the refuge would constitute a departure from the economically optimum plan. Unlike the other alternatives discussed previously, the refuge plan would provide an added function. Determining the advisability of including the refuge goes beyond finding the economically optimum scheme providing for the assessed needs of the basin and of Brown County since the proposal is a response to a national, or possibly international conservation need as opposed to a local or basin-wide need. It would require sacrificing a portion of the general recreation potential of the project. However, the proposed site for the refuge has a unique potential in terms of its topography and its geographic location relative to the established flyways.

Although the economic evaluation of the multiple purpose project with the refuge incorporated indicated a substantial reduction in net benefits, the overall project and each of its functions would remain economically justificable on the basis of increasing regional employment. Thus, three factors warrant consideration in determining the advisability of deviating from the economically optimum project to provide the refuge. First, neither the user benefits nor the economic expansion benefits ascribed to the refuge reflect the full value of the inviolate refuge in providing a unique opportunity to complement the existing migratory wildfowl flyway refuge system. The claimed benefits were based on alternative initial-only costs for existing refuges. Second, the refuge proposal was originated by the State of Ohio which has indicated its willingness to administer the refuge, to absorb the necessary cost sharing, and to forego the general recreation development that the refuge would pre-empt. Last, replacing a portion of the general recreation development with the refuge will actually enhance community amenities.

Alternative projects. The steep gradient of Whiteoak Creek and its narrow valley limits maximum storage capacities of potential reservoir sites along the main stem. In the upper basin, above the confluence of East Fork and North Fork, potential reservoirs would control greatly reduced drainage areas and also would be limited in storage capacity due to extensive improvements along the streams. Potential sites on the main stem between Georgetown and New Hope offer the largest storage capacity of any potential sites in the basin. Map studies and a reconnaissance of this stream reach revealed an adequate dam site near Georgetown which would provide more storage than any of the possible alternative upstream sites. Even this site would be severely limited in available capacity in relation to the drainage area controlled. Located 9.8 miles above the mouth of Whiteoak Creek, the selected site would control 214 square miles of drainage

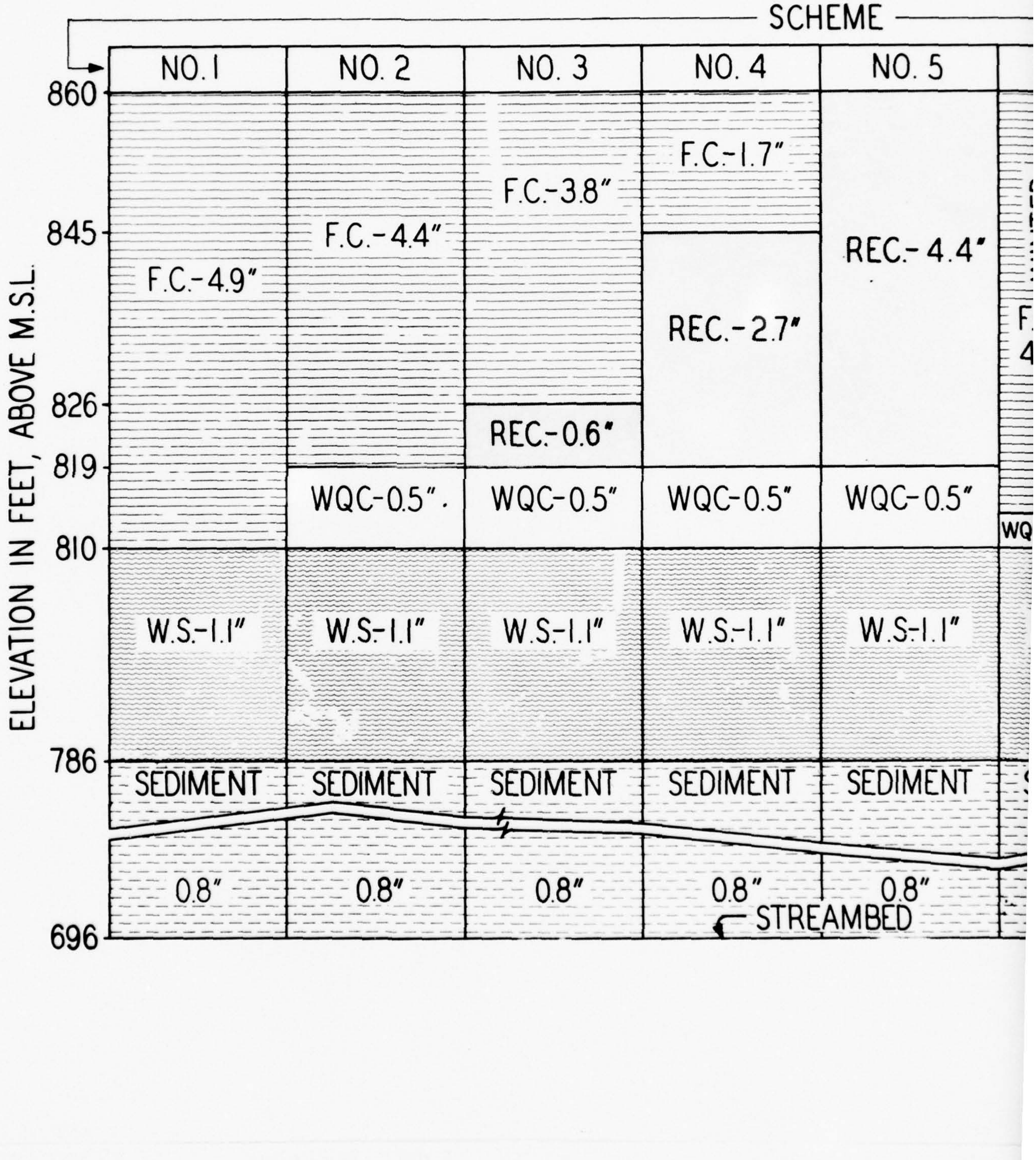
area out of a total of 234 square miles for the entire Whiteoak Creek basin. The possible alternatives to a multiple purpose reservoir at this site would be an upstream reservoir in combination with the multiple purpose project or two dual or triple-purpose projects. The upstream site could not provide sufficient storage for flood control in addition to storage required to satisfy current and future water supply and water quality control needs. Since there is only one practical alternative reservoir site (near New Hope) not mutually exclusive with the selected site, the selected site would have to serve as one of the projects acting in combination. Whether such an alternative plan for tandem reservoirs would provide the optimum plan would depend on the extent to which the selected site could provide for all assessed needs when acting alone. It, therefore, was necessary to develop the optimum plan for the selected multiple purpose site at Georgetown and to then determine the feasibility of departing from the optimum plan for this site by providing the upstream reservoir in tandem.

7. WHITEOAK DAM AND RESERVOIR - FORMULATION OF THE ECONOMICALLY OPTIMUM PLAN

In formulating the plan of development for the water project, all reasonable alternatives have been considered including the possibility of providing no multiple purpose reservoir and providing one of the available alternatives solely for water supply. The cost of the least expensive of the available alternatives, as discussed previously, was ascribed to the multiple purpose project as the benefits for its water supply function. Since the water supply function is incrementally justifiable, as is the overall multiple purpose project, then the sum of the multiple purpose costs to be allocated to water supply would be less than the alternate cost, thereby reflecting the inherent savings in the multiple purpose project. When applied to the water quality control function of the multiple purpose project, the same reasoning procedure results in a similar conclusion; that the multiple purpose project would be, in itself, the most feasible alternative when developed in accordance with the economically optimum plan.

Detailed hydrology and design studies for the Whiteoak Dam and Reservoir indicated that with an uncontrolled spillway, maximum storage would be limited to 6.8 inches of runoff. With a gated spillway structure, maximum storage could be increased by 1.7 inches to a total of 8.5 inches. Since preliminary cost and benefit estimates indicated that the incremental storage would be economically infeasible and since storage in the uncontrolled structure would be limited, project formulation studies were concentrated on alternative storage schemes in the uncontrolled structure having 6.8 inches of total storage but with varying storages for incremental purposes. Each alternative includes sufficient water supply storage to insure realization of the economic development objectives of the overall plan. Exhibit 14-2 illustrates the storage relationships in the pertinent schemes

ALTERNATIVE STORAGE SCHEMES UTILIZIN
AVAILABLE UNCONTROLLED SPILLWAY CREST,



2

E SCHEMES UTILIZING MAXIMUM
ED SPILLWAY CREST, ELEVATION 860

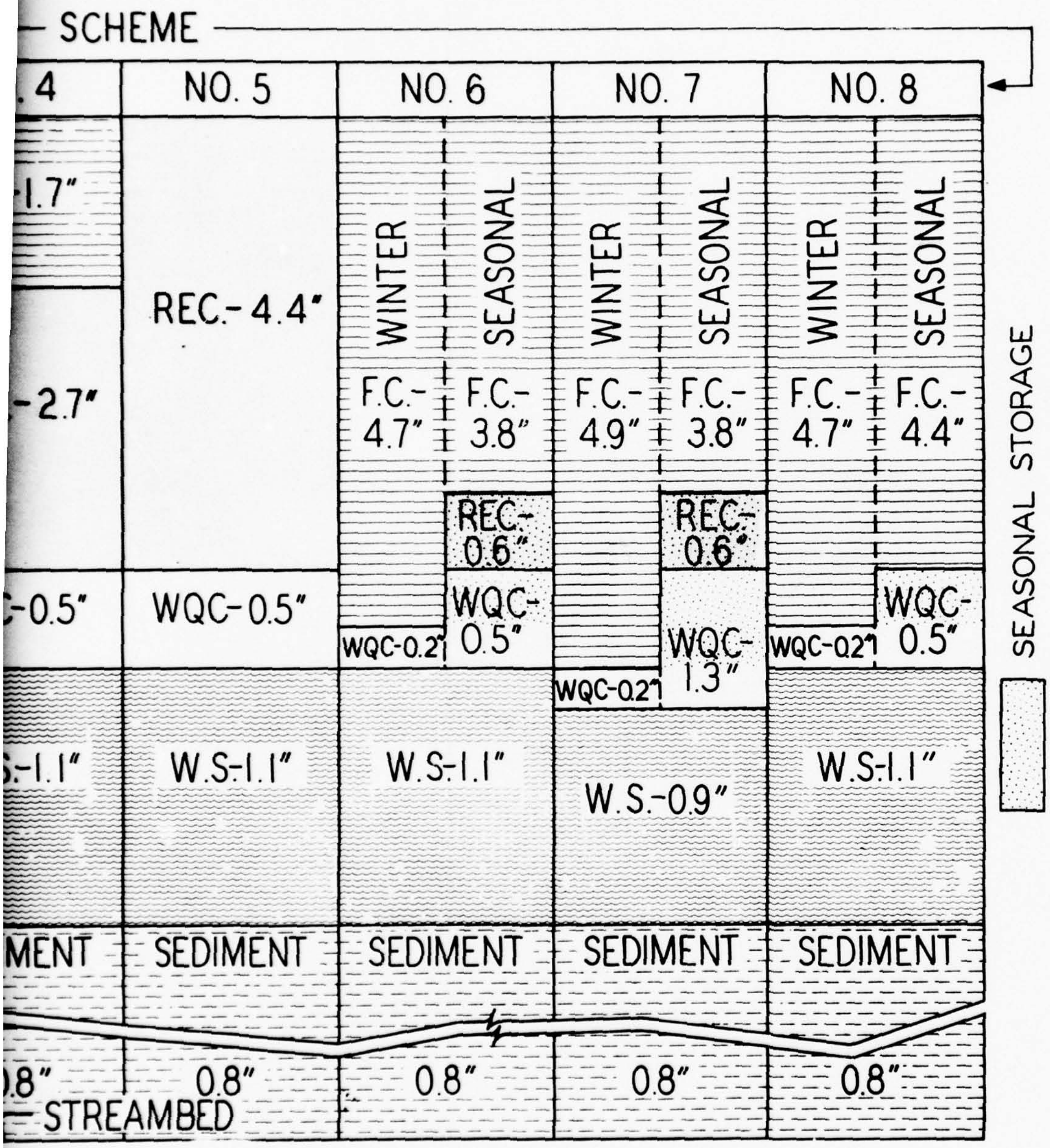


 EXHIBIT 14-2

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considered. Table 14-1 summarizes the average annual costs, benefits and net benefits for the eight basic schemes. Scheme number six would provide the maximum net user benefits and the maximum net user plus national account redevelopment benefits. Therefore, scheme number six was used as the basis for cost and benefit estimates for various scales of development, illustrated on Exhibit 14-3. Table 14-2 shows the costs, benefits, and net benefits for these alternatives. The additional storage available with a gated spillway is incrementally infeasible on the basis of user and redevelopment benefits (National or regional account). However, when the regional expansion effects of recreation visitor expenditures are considered, the incremental storage can be justified in scheme number eleven. When regional expansion benefits are considered, Scheme 6 fails to maximize net benefits, by increments ranging from $18 thousand to $164 thousand of annual net regional benefits foregone. Scheme 11 would provide an additional $164 thousand net regional benefits at the cost of $181.5 thousand net national benefits foregone. Thus on the basis of a mixed objective function, Scheme 11 would result in a net disadvantage of about $17.5 thousand annually ($164-$181.5), if regional benefits are given a weight equal to national benefits.

For purposes of comparison between alternative plans, those expansion benefits which remain constant throughout the comparison are omitted and those related to recreation expenditures which vary with the level of recreational development are included as variable expansion benefits. However, other important factors are left out of the estimate of net benefits given above. Strict comparison of benefits from flood control, water quality and recreation are difficult, since each purpose is valued by different procedures. Recreation and water quality are valued by imputed prices, whereas flood damages can be estimated from market prices. Scheme 11 is not as flexible operationally for total water control as is Scheme 6. Institutional constraints would inhibit the inclusion of such a plan as a Federal project.

Thus, Scheme 6 is considered to offer a better balanced and more practical means of meeting the multiple water needs of the area, while providing further attainment of the regional development objectives of the area. The incremental analysis utilized above somewhat obscures the fact that the dominant effect on regional income will come from the water supply function of the plan, which is held constant through all 12 alternatives considered.

Since there are no other multiple purpose reservoir sites available, the only remaining consideration was the advisability of providing two reservoirs, one of which would be at the multiple purpose site, and the other just upstream near New Hope. The upper site, as discussed previously, could not provide for all of the multiple functions combined. As a water supply and/or water quality control project, the upper reservoir could provide no additional user benefits for either of the two functions since all assessed water supply and water quality control needs can be met in the selected multiple purpose reservoir. When developed for water supply and/or water quality control, the potential for recreation development at the New Hope site would be incidental because of extreme fluctuation of the lake surface.

If the upstream project were used for flood control purposes, flood control storage could be deleted from the multiple purpose project and replaced by recreation storage (as in scheme number five). The additional benefits to be derived would amount to $484,000 annually, including incremental user, regional account redevelopment, and regional account recreation visitor expenditure benefits. Incremental costs would amount to at least $649,300. Therefore, using the upper reservoir for flood control is incrementally infeasible. Clearly, the best use of the upper reservoir would be for recreation only; leaving the multiple purpose reservoir as formulated for single project development. Preliminary estimates of costs and benefits for a single purpose recreation project at the New Hope site indicate that such a project would be economically justifiable on the basis of user benefits alone. This project would not be necessary to the attainment of the objectives of the overall plan of development and would not affect conclusions as to the optimum plan. Therefore, the project would be the responsibility of the State of Ohio or other local interests should they determine it to be desirable. The Brown County land use plan provides for this possibility by designating the lands in the area of the New Hope reservoir for public open-space usage.

The economically optimum plan for Whiteoak Reservoir modified to incorporate the migratory goose refuge was selected as being most appropriate to the overall plan of development. The reservoir plan could be complemented by development of a comprehensive recreation development plan for the Whiteoak Creek basin and Brown County. The recreation lake which has been proposed by the Soil Conservation Service as a part of its plan for the upper Whiteoak Creek watershed should be coordinated and planned to complement the Whiteoak Reservoir with the refuge. A third reservoir near New Hope could be developed by State or local interests to provide further recreation development to meet the growing demand. These three reservoirs plus the existing Lake Grant would be in the same general area, as shown on Sheet 1 of Exhibit 14-4. Together, these reservoirs would form an outstanding conservation and recreation complex in an area of extremely heavy demand. The industrial, commercial and residential components of the developmental plan would blend harmoniously with such a complex. Viewed from the broader perspective of a complex of projects, the variety of usage and uniqueness offered by the refuge takes on a more significant value. It is mainly for this reason that inclusion of the refuge in the water project plan is considered to be desirable. The overall recreation plan for Whiteoak Reservoir is shown in Sheet 2 of Exhibit 14-4.

The U. S. Fish and Wildlife Service indicated that the primary advantage of using the Whiteoak Reservoir for the refuge in lieu of a similar management unit at the SCS project would be the savings afforded by joint use lands. This is not a valid comparison when judged from the total National efficiency perspective, since utilization of all the joint use lands for general recreation development instead of a management unit yields substantially greater returns.

TABLE 14-1
WHITEOAK RESERVOIR
WATER PROJECT NET BENEFIT ANALYSIS
($1000)

	SCHEMES							
	1	2	3	4	5	6	7	8
BENEFITS								
User:								
Flood control	265.0	244.0	217.0	15.4	0.0	257.3	265.0	257.3
Recreation	1,656.7	1,670.4	1,725.4	1,830.4	1,959.1	1,725.4	1,725.4	1,670.4
Water supply	216.1	216.1	216.1	216.1	216.1	216.1	173.5	216.1
Water quality control	0.0	170.2	170.2	170.2	170.2	170.2	170.2	170.2
Total, User	2,137.8	2,300.7	2,328.7	2,232.1	2,345.4	2,369.0	2,334.1	2,314.0
NATIONAL								
User:	2,137.8	2,300.7	2,328.7	2,232.1	2,345.4	2,369.0	2,334.1	2,314.0
National Redevelopment	234.3	240.0	242.1	251.0	256.3	242.1	242.1	240.0
User + National Redevelopment	2,372.1	2,540.7	2,570.8	2,483.1	2,601.7	2,611.1	2,576.2	2,554.0
National Recreation Expansion 1/	197.5	199.1	205.5	217.8	232.2	205.5	205.5	199.1
User + National Red. + Nat. Rec. Expans.	2,569.6	2,739.8	2,776.3	2,700.9	2,833.9	2,816.6	2,781.7	2,751.3
REGIONAL								
User:	713.1	887.4	903.9	935.4	974.0	903.9	861.3	887.4
Regional Redevelopment	689.5	709.0	716.0	746.2	758.9	716.0	716.0	709.0
User + Regional Redevelopment	1,402.6	1,596.4	1,619.9	1,681.6	1,732.9	1,619.9	1,577.3	1,596.4
Regional Recreation Expansion 1/	1,542.4	1,555.2	1,605.0	1,701.3	1,813.6	1,605.0	1,605.0	1,555.2
User + Reg. Red. + Reg. Rec. Expans.	2,945.0	3,151.6	3,224.9	3,382.9	3,546.5	3,224.9	3,182.3	3,151.6
COSTS								
Average Annual Economic	2,002.3	2,032.0	2,059.2	2,147.2	2,206.5	2,059.2	2,059.2	2,032.0
Private Invest. for Reg. Rec. Visitor Expend.	74.3	75.0	77.7	82.8	88.7	77.7	77.7	75.0
Private Invest. for Nat. Rec. Visitor Expend.	57.8	58.4	60.4	64.3	69.1	60.4	60.4	58.4
NET BENEFITS								
User, National	135.5	268.7	269.5	84.9	138.9	309.8	274.9	282.0
User + National Redevelopment	396.8	508.7	511.6	335.9	395.2	551.9	517.0	522.0
User + Nat. Red. + Nat. Rec. Expans.	509.5	649.4	656.7	489.4	558.3	697.0	662.1	662.7
User, Regional 2/	-1,289.2	-1,144.6	-1,155.3	-1,211.8	-1,232.5	-1,155.3	-1,197.9	-1,144.6
User + Regional Redevelopment	-599.7	-435.6	-439.3	-465.6	-473.6	-439.3	-481.9	-435.6
User + Reg. Red. + Reg. Rec. Expans.	868.4	1,044.6	1,088.0	1,152.9	1,251.3	1,088.0	1,045.4	1,044.6

1/ Recreation Visitor expenditures, variable with scale of recreation development.
2/ Excludes Ohio River flood control benefits and recreation benefits derived by recreationist from outside Appalachia.
Note: None of the above Schemes include the goose refuge.

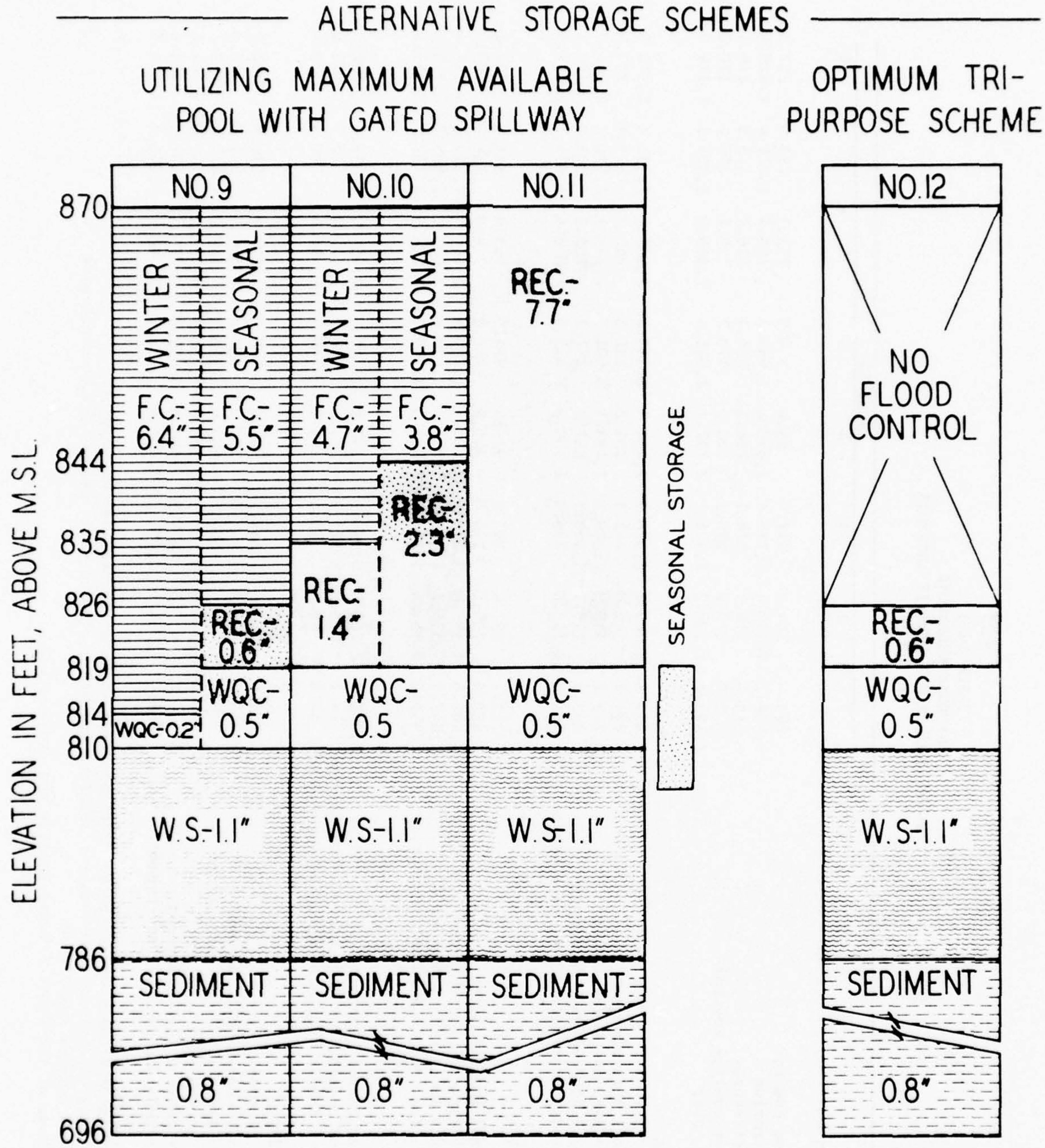
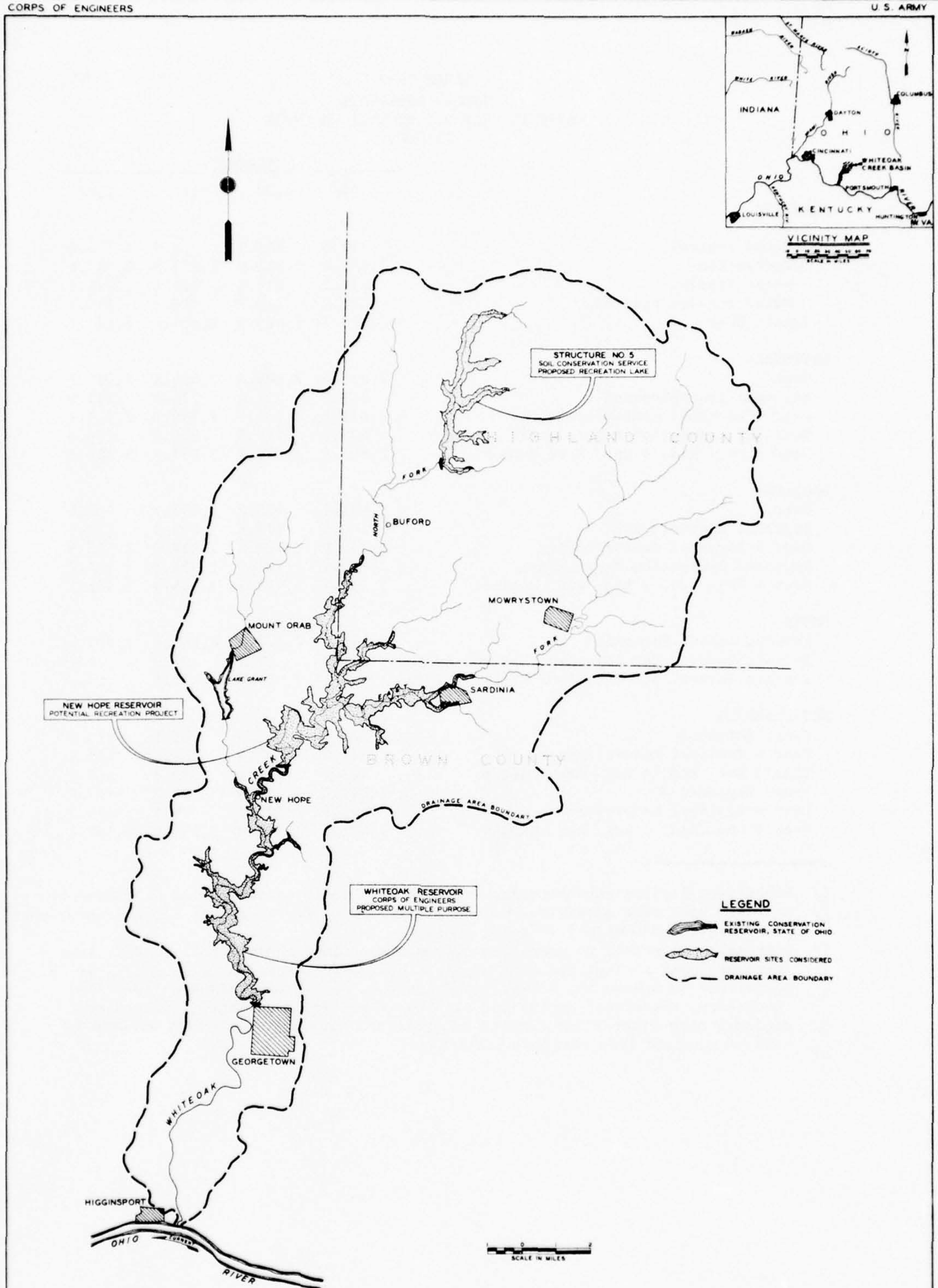

ALTERNATIVE STORAGE SCHEMES
UTILIZING MAXIMUM AVAILABLE POOL WITH GATED SPILLWAY
OPTIMUM TRI-PURPOSE SCHEME
NO.9
NO.10
NO.11
NO.12
ELEVATION IN FEET, ABOVE M.S.L.
870
844
835
826
819
814
810
786
696
WINTER
SEASONAL
F.C.-6.4"
F.C.-5.5"
F.C.-4.7"
F.C.-3.8"
REC.-7.7"
REC.-2.3"
REC.-1.4"
REC.-0.6"
NO FLOOD CONTROL
WQC-0.2"
WQC-0.5"
WQC-0.5
W.S.-1.1"
SEDIMENT
0.8"
SEASONAL STORAGE

EXHIBIT 14-3

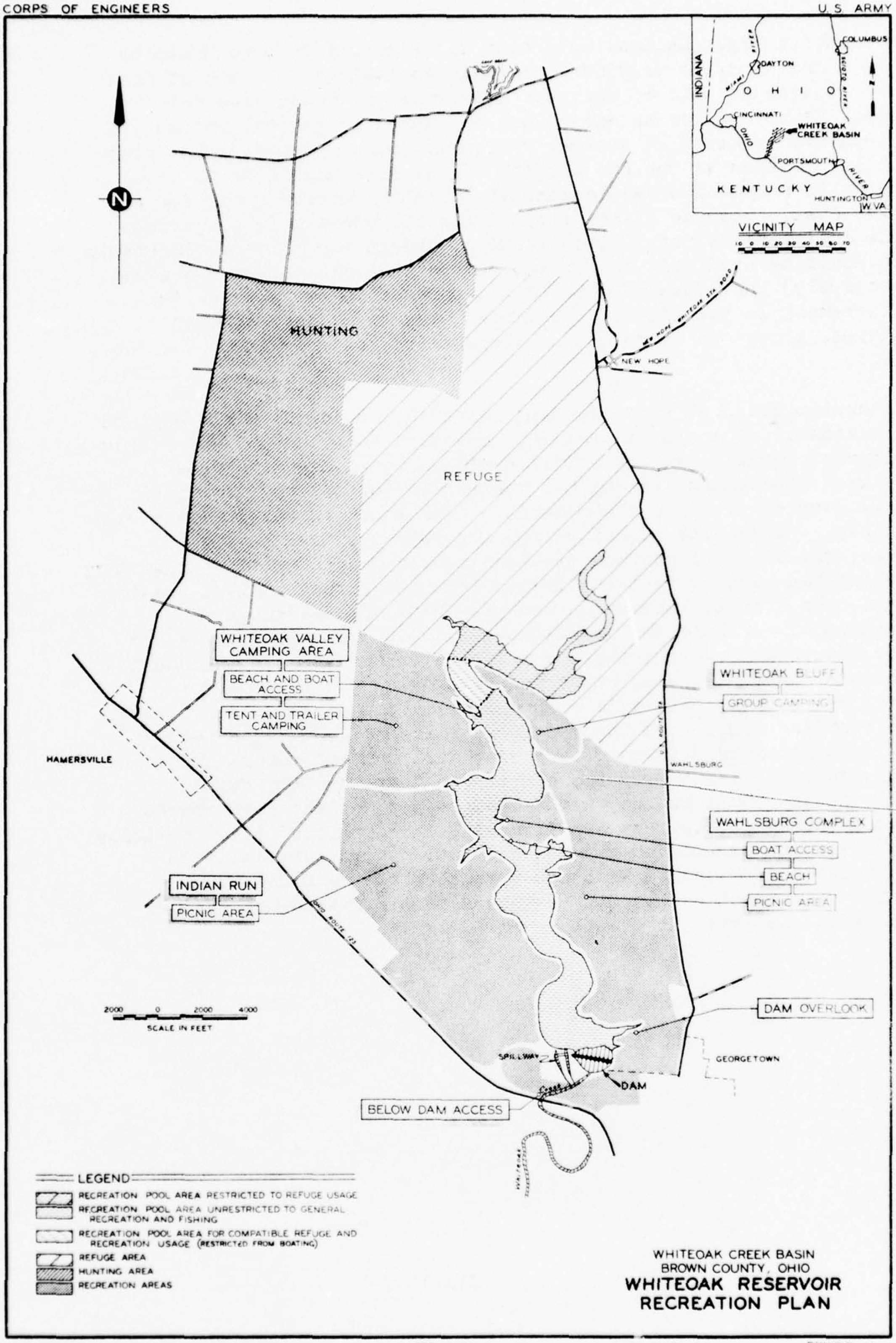
TABLE 14-2
WHITEOAK RESERVOIR
WATER PROJECT NET BENEFIT ANALYSIS
($1000)

	SCHEMES			
	9 2/	10 3/	11	12 4/
BENEFITS				
User:				
Flood control	312.0	257.3	0.0	0.0
Recreation	1,725.4	1,822.9	2,077.9	1,725.4
Water supply	216.1	216.1	216.1	216.1
Water quality control	170.2	170.2	170.2	170.2
Total, User	2,423.7	2,466.5	2,464.2	2,111.7
NATIONAL				
User	2,423.7	2,466.5	2,464.2	2,111.7
National Redevelopment	245.7	254.4	276.6	211.9
User + National Redevelopment	2,678.4	2,720.9	2,740.8	2,323.6
National Recreation Expansion 1/	205.5	217.8	246.6	205.5
User + Nat. Red. + Nat. Rec. Expans.	2,883.9	2,938.7	2,987.4	2,529.1
REGIONAL				
User	903.9	933.2	1,009.7	903.9
Regional Redevelopment	746.9	776.6	809.3	652.6
User + Regional Redevelopment	1,650.8	1,709.8	1,819.0	1,556.5
Regional Recreation Expansion 1/	1,605.0	1,701.3	1,926.0	1,605.0
User + Reg. Red. + Reg. Rec. Expans.	3,255.8	3,411.1	3,745.0	3,161.5
COSTS				
Average Annual Economic	2,145.6	2,223.0	2,398.4	1,901.4
Private Invest. for Reg. Rec. Visitor Expend.	77.7	82.3	94.6	77.7
Private Invest. for Nat. Rec. Visitor Expend.	60.4	64.0	73.5	60.4
NET BENEFITS				
User, National	278.1	243.5	65.8	210.3
User + National Redevelopment	523.8	497.9	342.4	422.2
User + Nat. Red. + Nat. Rec. Expans.	668.9	651.7	515.5	567.3
User, Regional 5/	-1,241.7	-1,289.8	-1,388.7	-997.5
User + Regional Redevelopment	-494.8	-513.2	-579.4	-344.9
User + Reg. Red. + Reg. Rec. Expans.	1,032.5	1,105.8	1,252.0	1,182.4

1/ Recreation Visitor expenditures, variable with scale of recreation development.
2/ Seasonal pool same elevation and storage as scheme No. 6, except flood control pool at elevation 870 with 1.7" added storage.
3/ Seasonal pool raised to elevation 844, maximum flood control pool to 870, same seasonal pool storage and same winter flood control storage as in scheme No. 6.
4/ Equivalent to scheme No. 6 less flood control, no seasonal drawdown for flood necessary, therefore, equivalent also to scheme No. 3 without flood control.
5/ Excludes Ohio River flood control benefits and recreation benefits derived by recreationists from outside Appalachia.



WHITEOAK CREEK BASIN, OHIO
PROPOSED AND POTENTIAL RECREATION LAKES



WHITEOAK CREEK BASIN
BROWN COUNTY, OHIO
WHITEOAK RESERVOIR RECREATION PLAN

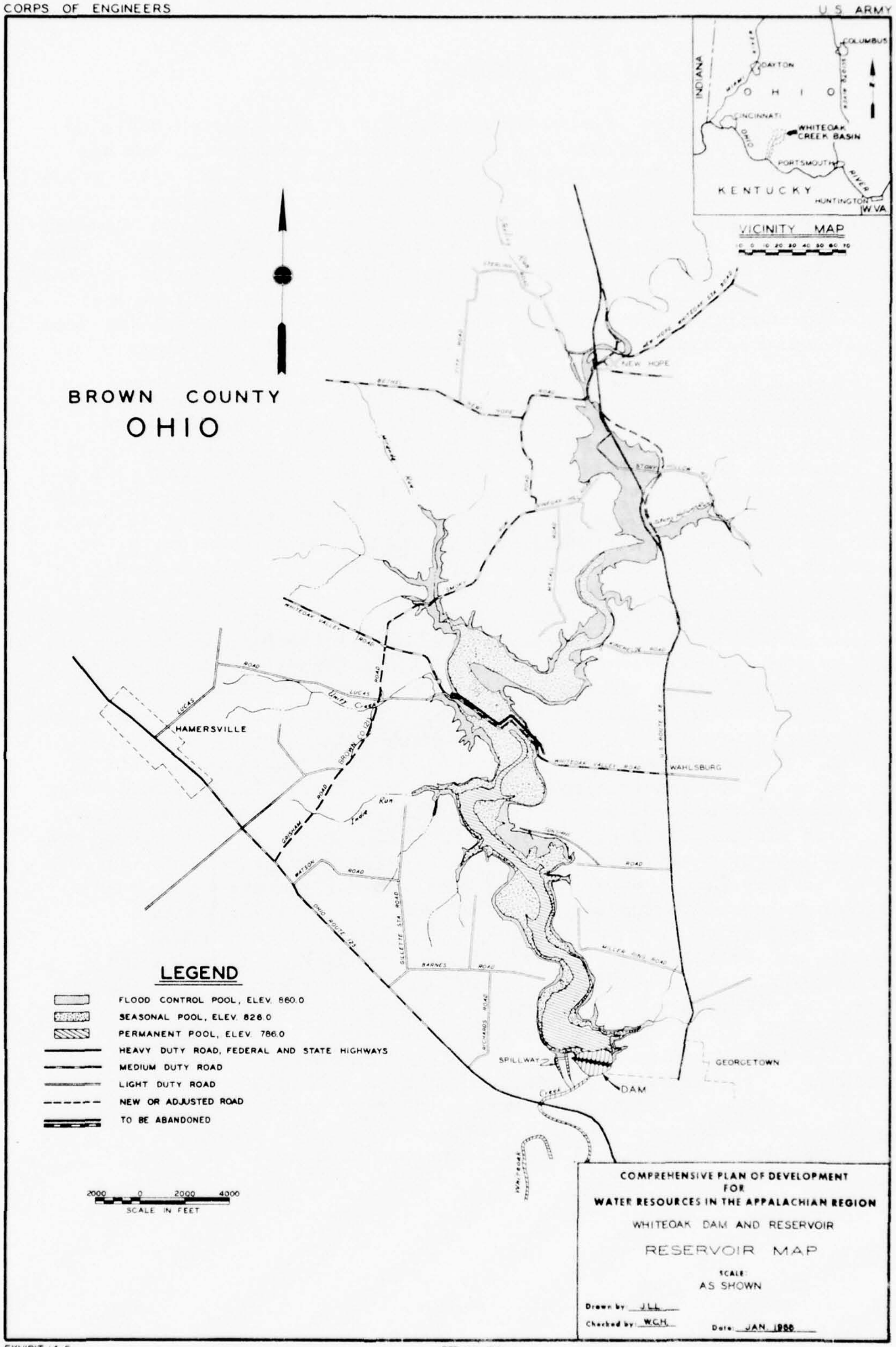
Therefore, it might be concluded that the alternative considered by the Fish and Wildlife Service is roughly equivalent in terms of cost to the management unit at Whiteoak Reservoir and would free the Whiteoak Reservoir for an additional increment of general recreation development. However, a general recreation plan of development also could be provided at the SCS project of the same magnitude as the incremental recreation development at Whiteoak Reservoir and for a similar cost. Because of the size of the SCS project in comparison to the additional acreage of recreation lake at the Whiteoak Reservoir which would be available to general recreation (580 versus 184 acres, respectively) the potential of the SCS project is far greater than the increment in question at the Corps' project. The aesthetic qualities, access to shore and developability actually favor the SCS project.

A continuation of the preceding reasoning obviously would exclude any reasonably developable land area adjacent to a body of water from development for a migratory wildlife refuge until the time general recreation development throughout the region (or country, for that matter) completely meets the demands. Such a conclusion is rationally untenable. It results directly from the method of evaluation. Whereas, the benefits for the propagation and conservation of migratory waterfowl has been derived explicitly from the actual cost of existing refuges, the general recreation benefits have been based on an assumption of worth to the recreationist. The economic cost to the nation incurred in developing the existing refuges should include the incremental benefits foregone by not developing these areas for general recreation. Had this economic cost been included in the unit benefit factor applied to the refuge at Whiteoak Creek, the refuge would have compared favorably to incremental general recreation development. It is, therefore, considered that the only valid consideration should be one which measures the desirability of providing a refuge development and foregoing the opportunity to partially meet the latent demand for general recreation opportunities. The Ohio Division of Wildlife with concurrence from the Director of the Ohio Department of Natural Resources has expressed its desire for a refuge at Whiteoak Creek.

8. THE SELECTED PLAN OF DEVELOPMENT

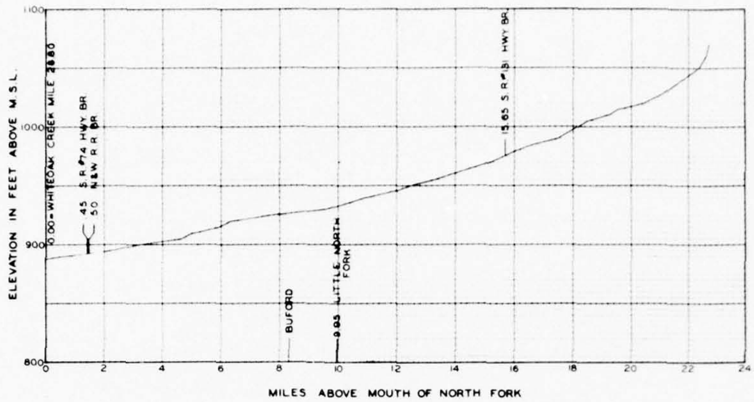
The overall plan of development for the Whiteoak Creek Basin and Brown County would include the water resources project and the associated economic development necessary to complement the water project and achieve the benchmark objectives. The associated economic development plan would include the composite of physical and organizational plans necessary to insure the magnitude of induced public and private investment which, in turn, is required to provide the benchmark levels of economic activity. The induced investment would be the desired result of these plans. The beneficial effects resulting from the investment would be the benefits attributable to the plan.

As shown on Exhibit 14-1, the water resources project, Whiteoak Dam and Reservoir, would be located 9.8 miles above the mouth of Whiteoak Creek and control a drainage area of 214 square miles. A reservoir map and streambed profiles are included as Exhibit 14-5 and 14-6, respectively. The reservoir would provide 53,800 acre-feet of flood control storage in the winter and 43,700 acre-feet of flood control storage in the summer, or 4.7 and 3.8 inches of runoff, respectively, from the controlled area. Year-around and seasonal storage of 34,500 acre-feet would provide for water supply, water quality control and recreation. Water supply storage (12,450 acre-feet) would provide 16.5 million gallons per day, sufficient to furnish the total water supply demands including incorporation of existing supply sources which currently provide roughly 0.7 million gallons per day. The water for municipal and industrial supplies would be pumped directly from the reservoir to a central treatment plant serving the entire basin. The treatment plant and distribution lines would have to be provided by non-Federal interests. The water quality control storage (6,150 acre-feet) would provide for releases sufficient to maintain minimum flows of 14.3 c.f.s. along Whiteoak Creek for nine out of ten years and would maintain a flow of 5.0 c.f.s. 100 percent of the time as a minimum. Water quality control benefits are considered to be widespread. The benefits that would be obtained through water quality control of Whiteoak Creek, would accrue to the people of southwestern Ohio and northern Kentucky. Although the storage capacity required to augment the natural stream flows in Whiteoak Creek is relatively small, flow augmentation would occur in the Ohio River; however, benefit determination is not possible at this time. Recreation and refuge development has been planned to utilize the 931 acre seasonal pool which includes 6,400 acre-feet of storage specifically for general recreation. Beneath the water supply and water quality control pool, 9,500 acre-feet of storage would be provided for sediment accumulation.

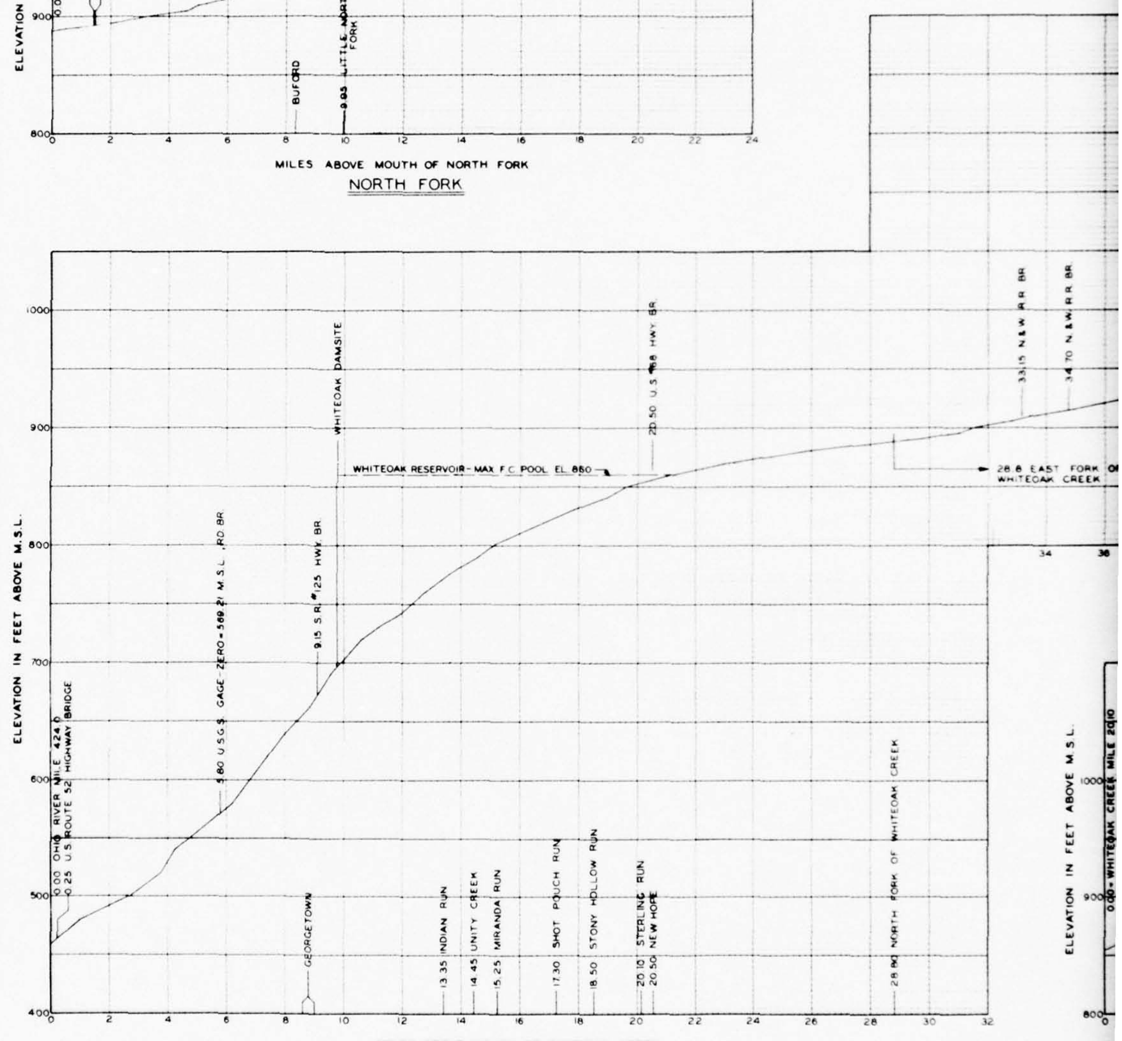


COLUMBUS
DAYTON
INDIANA
OHIO
CINCINNATI
WHITEOAK CREEK BASIN
PORTSMOUTH
KENTUCKY
HUNTINGTON
W.VA.
VICINITY MAP
BROWN COUNTY
OHIO
NEW HOPE
HAMERSVILLE
WAHLSBURG
GEORGETOWN
SPILLWAY
DAM
LEGEND
FLOOD CONTROL POOL, ELEV. 860.0
SEASONAL POOL, ELEV. 828.0
PERMANENT POOL, ELEV. 786.0
HEAVY DUTY ROAD, FEDERAL AND STATE HIGHWAYS
MEDIUM DUTY ROAD
LIGHT DUTY ROAD
NEW OR ADJUSTED ROAD
TO BE ABANDONED
2000 0 2000 4000
SCALE IN FEET
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
WHITEOAK DAM AND RESERVOIR
RESERVOIR MAP
SCALE:
AS SHOWN
Drawn by: J.L.L.
Checked by: W.C.H.
Date: JAN. 1966

CORPS OF ENGINEERS



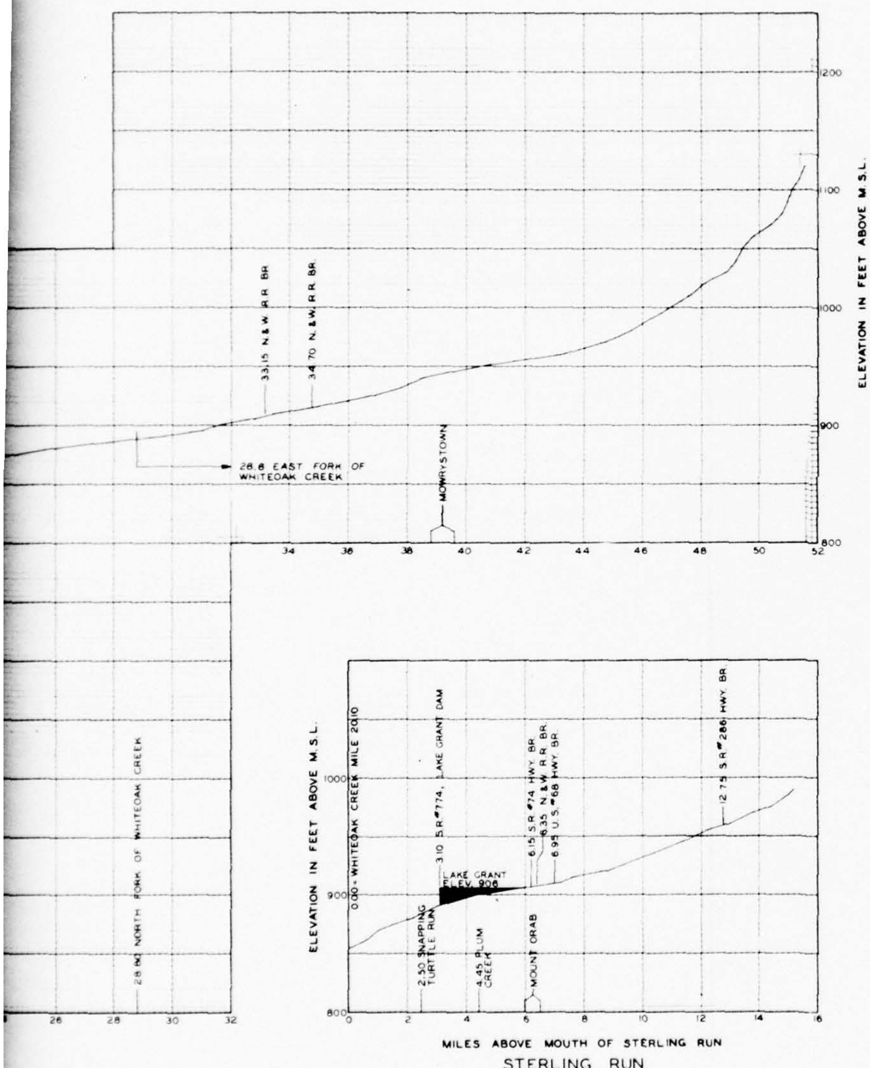
NORTH FORK



WHITEOAK CREEK
(INCLUDES EAST FORK OF WHITEOAK CREEK)

U.S. ARMY

2



STERLING RUN

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK BASIN
OHIO
STREAMED PROFILES

SCALE
AS SHOWN

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SECTION III - DESIGN CONSIDERATIONS

9. HYDROLOGIC

Physical Characteristics of Drainage Basin. Whiteoak Creek Basin is located entirely within the State of Ohio in Brown and Highland Counties. Whiteoak Creek rises in Highland County, Ohio, and flows in a southerly direction for approximately 52 miles to its confluence with the Ohio River near Higginsport, Ohio, 424.0 river miles below Pittsburgh, Pennsylvania, and approximately 46 miles upstream from Cincinnati, Ohio. Whiteoak Creek watershed lies adjacent to Ohio Brush Creek Basin on the east and Little Miami River Basin on the west. Exhibit 14-1 shows the location of Whiteoak Creek Basin with respect to the Ohio River.

Whiteoak Creek Basin has a drainage area of 234 square miles and is roughly fan-shaped. The drainage basin is approximately 30 miles in length; averages 12 miles in width in the northern portion; and narrows down to approximately four miles in width in the southern part. Table 14-3 lists drainage areas of Whiteoak Creek and principal tributaries.

The topography of the basin has a maximum relief of about 725 feet. The upper portion of the basin consists of broad productive flood plains in rolling glaciated land. In the lower reach are found narrow valleys, averaging about 600 feet in width, between hills rising abruptly 150 to 200 feet above the river.

Stream Characteristics. The source of Whiteoak Creek is in Highland County and flows in a southerly direction as the East Fork of Whiteoak Creek to its confluence with the smaller North Fork a distance of 23 miles. In this reach, North Fork and East Fork meander through broad flood plains; the average slope is 10.2 feet per mile. The stream, from its forks to Georgetown in Brown County, flows through a transition as it cuts through the glacial till into bedrock; the average slope is 11.4 feet per mile. In the lower reach, the stream is entrenched in a narrow valley between steep hills. The flood plain averages 600 feet in width, and the average slope is 23 feet per mile. Principal tributaries of Whiteoak Creek are East Fork, North Fork and Sterling Run. The East and North Forks drain approximately 63 percent of the basin. East Fork is considered locally as a part of the main stem of Whiteoak Creek. The stream profile, including East Fork, is relatively steep, dropping from elevation 1120 feet at the headwaters to elevation 458 feet at the mouth; in the 52 miles of flow the average fall is 12.8 feet per mile. Pertinent data on Whiteoak Creek and its principal tributaries are given in Table 14-3.

TABLE 14-3

DRAINAGE AREAS AND STREAM CHARACTERISTICS OF WHITEOAK CREEK AND PRINCIPAL TRIBUTARIES

Stream	Drainage area, sq. mi.	Elevation at source, feet above m.s.l.	Distance above mouth of Whiteoak Creek, miles	Length of stream, miles	Average slope, feet per mile
North Fork of Whiteoak Creek	67.7	1070	28.8	22.7	8.0
East Fork of Whiteoak Creek	80.8	1120	28.8	22.8	10.2
Sterling Run	28.5	990	20.1	15.3	8.8
Whiteoak Creek 1/	234.3	1120	0.0	51.6	12.8

1/ Includes East Fork as part of the main stem

General Climatology. The climate of Whiteoak Creek Basin is essentially continental in nature and includes the usual seasonal variations in temperature. The basin is affected by frontal air-mass activity and is subject to both continental polar and maritime tropical air masses. Frequent and rapid changes in weather occur, due to the passage of fronts associated with general low-pressure areas. Prevailing wind direction is from the southwest.

Climatological Records. Meteorological data for Whiteoak Creek Basin are available from numerous nearby stations, but from none within the basin. The locations, elevations, periods of record and average annual data are given in Table 14-4. The present network does not afford adequate coverage. Flood control studies have been based on limited data provided by the meager network. The distribution of the stations is shown on Exhibit 14-7.

Temperature. The mean annual temperature of the basin is about 54 degrees. Seasonal variations in temperature range from an average of about 35 degrees in January to 77 degrees in July. The growing season, or the period between the last killing frost of spring and the first killing frost of autumn, averages six months, usually from mid-April to mid-October. Average annual temperatures for individual stations are listed in Table 14-4. Monthly average temperatures for Hillsboro, Ohio, are listed in Table 14-5.

TABLE 14-4

METEOROLOGICAL STATIONS NEAR WHITEOAK CREEK BASIN

Station	Watershed	Elevation ft. m.s.l.	Period of record	Equipment1/	Average annual3/ Temp.	Precip.	Snowfall
Chilo, Meldahl Dam, Ohio	Ohio R.	500	1920-Date	NR, R, T	53.9	40.21	12.6
Cincinnati WB City, Ohio	Ohio R.	553	1871-Date	NR, R, T	55.2	38.76	18.8
Falmouth 5 WNW, Ky.	Licking R.	715	1887-Date	NR, T	54.2	41.95	13.0
Higginsport, Ohio	Ohio R.	500	1945-Date	NR		43.32	2/
Hillsboro 5S, Ohio	Scioto R.	1090	1892-1902 1908-Date	NR, R, T	53.0	41.79	24.2
Hillsboro Wtr. Wks., Ohio	Scioto R.	940	1941-1964	R			
Maysville SWG Plt., Ky.	Ohio R.	515	1896-Date	NR, R, T	55.1	43.64	15.4
McKinneysburg, Ky.	Licking R.	662	1939-Date	R		41.15	
Milford, Ohio	Little Miami R.	570	1951-Date	NR, T	53.7	39.11	2/
Oneonta Dam 35, Ky.	Ohio R.	512	1921-1963	NR		40.08	15.5
Peebles, 1-S, Ohio	Ohio R.	825	1910-1962	NR, T	54.0	40.27	12.7
Peebles, Ohio	Ohio R.	810	1939-Date	NR, R, T			
Ripley Exp. Farm, Ohio	Ohio R.	890	1959-Date	NR, T	2/	2/	2/
St. Martin Ursuline School, Ohio	Little Miami R.	985	1939-Date	R		39.58	
Wilmington, Ohio	Little Miami R.	1026	1915-Date	NR, T	53.0	45.02	31.4
Wilmington Wtr. Pl., Ohio	Little Miami R.	1040	1941-Date	R			

1/ R: Recording precipitation gage
NR: Non-recording precipitation gage
T: Thermometer, maximum and minimum
2/ Insufficient data available to determine value
3/ From "Climatography of the United States No. 86-29 & 86-13"

TABLE 14-5

CLIMATIC SUMMARY

Station	Yrs. of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Normal monthly & annual temperature, degrees Fahrenheit														
Hillsboro, Ohio	64	30.8	32.3	41.6	52.1	61.8	70.5	74.1	72.7	66.9	55.7	43.1	33.6	52.9
Average monthly & annual maximum temperature, degrees Fahrenheit														
Hillsboro, Ohio	62	39.9	41.8	52.1	63.7	73.5	82.4	85.7	84.3	79.1	67.9	53.3	41.7	63.8
Average monthly & annual minimum temperature, degrees Fahrenheit														
Hillsboro, Ohio	65	21.7	22.6	30.7	40.4	50.2	59.2	62.6	60.9	54.5	43.2	32.8	24.2	42.0
Average monthly & annual precipitation, inches														
Hillsboro, Ohio	87	3.55	2.93	4.02	3.85	3.76	3.92	4.42	3.82	3.02	2.38	3.03	3.20	41.91
Maximum monthly & annual precipitation, inches														
Hillsboro, Ohio	87	14.72	7.00	12.51	8.45	9.79	9.14	9.86	10.26	9.59	5.90	7.35	8.08	55.56
Minimum monthly & annual precipitation, inches														
Hillsboro, Ohio	87	.85	.36	.04	1.01	.62	.59	.53	.77	.30	.03	.37	.44	23.46
Maximum 24-hour precipitation, inches														
Hillsboro, Ohio	74	2.10	2.40	4.70	3.41	4.20	3.48	7.20	3.28	3.20	3.08	2.24	2.26	7.20
Normal monthly & annual snowfall, inches														
Hillsboro, Ohio	64	7.0	6.3	3.9	0.7	0	0	0	0	0	0.3	1.8	4.6	24.7

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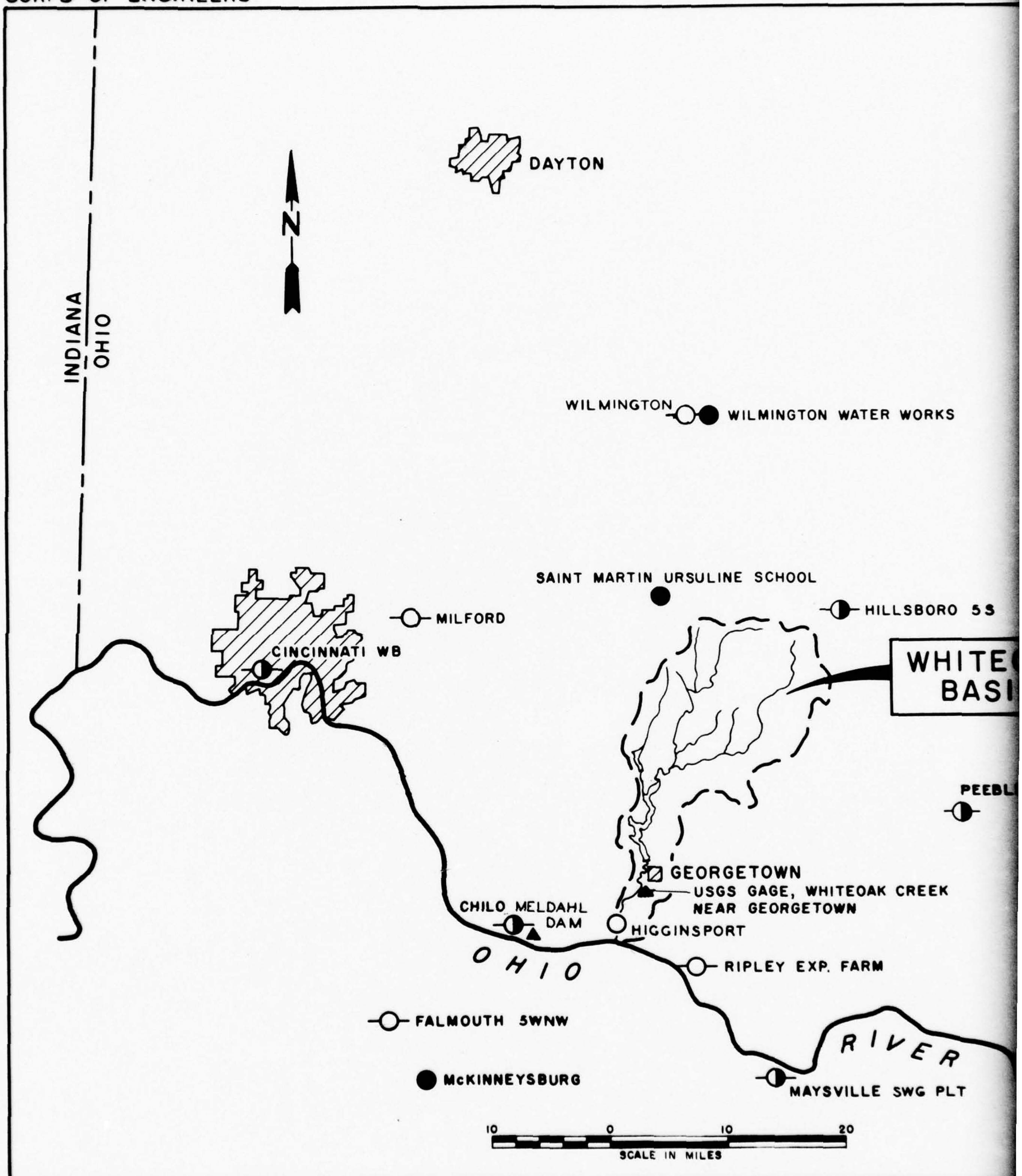
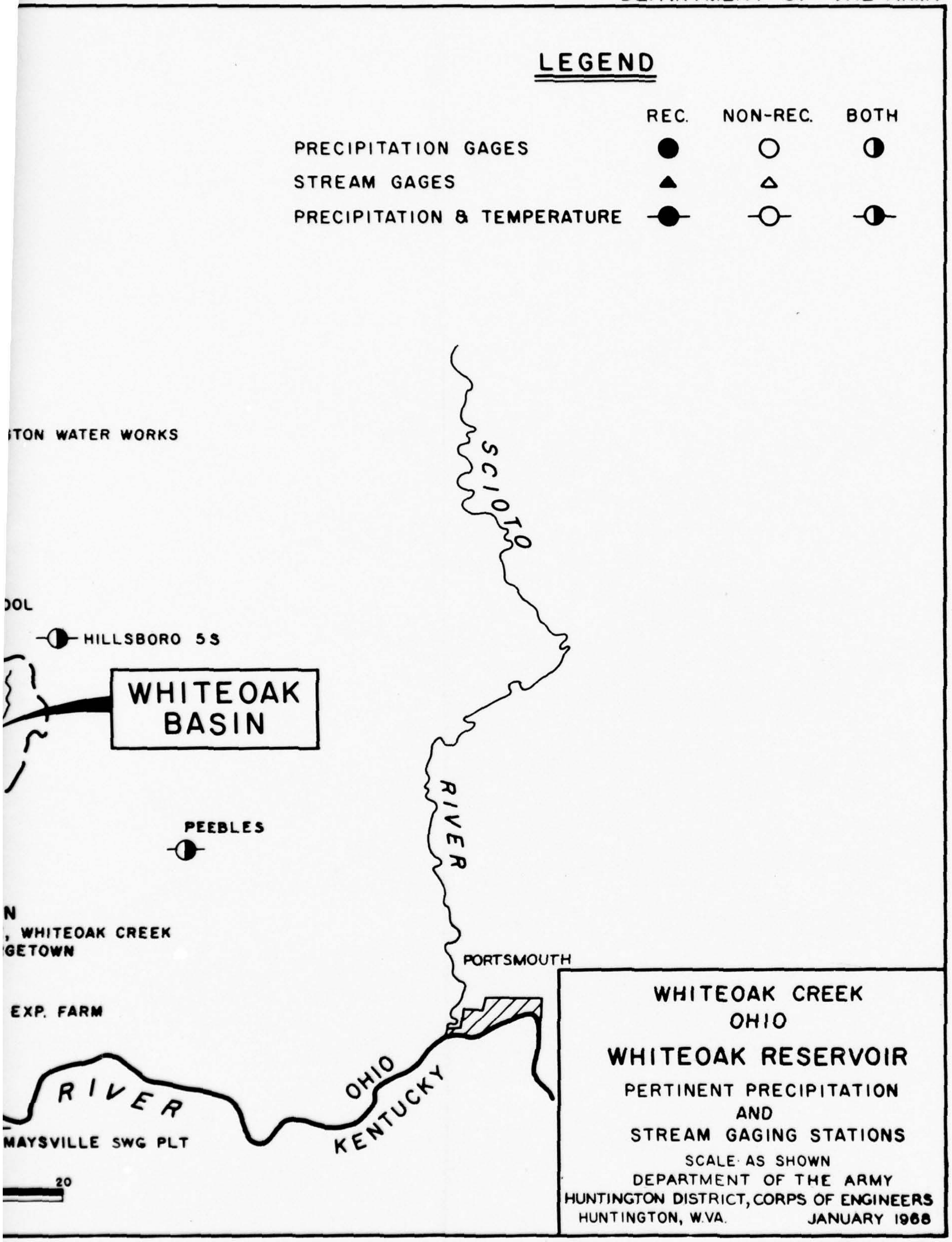


DEPARTMENT OF THE ARMY



WHITEOAK CREEK
OHIO
WHITEOAK RESERVOIR
PERTINENT PRECIPITATION
AND
STREAM GAGING STATIONS
SCALE AS SHOWN
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

 EXHIBIT 14-7

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Precipitation. Annual precipitation over the basin averages approximately 42 inches and is listed for individual stations in Table 14-4. Normally, precipitation is adequate for all needs but there have been infrequent drought periods. Monthly average and maximum 24-hour precipitation for Hillsboro, Ohio, are listed in Table 14-5. The average annual snowfall over the basin is about 18 inches and represents only a minor portion of the total annual precipitation. Average annual snowfall for individual stations is listed in Table 14-4. Average monthly snowfall for Hillsboro, Ohio, is listed in Table 14-5. The basin lies in the normal path of extensive meteorological disturbances which, in winter and spring, generally travel from southwest to northeast over the long axis of the basin. Two distinct types of storms are prevalent in the area, the summer and winter-type storms. The summer-type usually occurs during the period, May to November, inclusive, and is characterized by rainfall of high intensity, short duration, and relatively small areal extent. The winter-type usually occurs during the period, December to April, inclusive, and is characterized by less intense rainfall of extended duration and large areal extent. Summer rains usually result from thunderstorms of conventional frontal activity of convectional or orographic origin. Winter-type storms are generally caused by the passage of a low-pressure system over the basin. Occasional stagnation and stationary development produce prolonged precipitation over the basin.

Stream Flow Records. The United States Geological Survey has maintained a stream gaging station on Whiteoak Creek near Georgetown from October 1923 to November 1935 and from October 1939 to date. Pertinent data for this station follow:

Drainage area, square miles	222
Location, miles above mouth	5.8
Type of gage	Water-stage recorder and wire-weight gage
Maximum stage, feet	14.64 (March 1964)
Maximum discharge, cubic feet per second	22,400 (March 1964)
Minimum discharge, cubic feet per second	0
Average discharge, cubic feet per second	244

Runoff. Basin runoff is highest during the winter months when storm rainfall may be augmented by snow melt and when frozen or saturated ground results in low infiltration rates. Runoff is lowest during the summer and early fall when the ground is dry and losses are highest. The mean annual runoff of Whiteoak Creek has averaged about 1.1 cubic feet per second per square mile during the period of record at Georgetown. Table 14-6 presents monthly runoff data for Whiteoak Creek near Georgetown, Ohio.

TABLE 14-6

MONTHLY RUNOFF
WHITEOAK CREEK NEAR GEORGETOWN

Month	Monthly runoff, inches		
	Mean	Maximum	Minimum
January	2.45	7.76	.08
February	2.35	6.04	.06
March	2.98	9.50	.22
April	2.00	5.53	.29
May	1.15	5.88	.06
June	.79	3.02	.04
July	.52	2.37	.005
August	.40	2.77	.0007
September	.32	2.71	.0001
October	.21	2.03	.0004
November	.61	3.15	.0009
December	1.37	4.45	.009

Datum of gage 569.21 feet above m.s.l.
Period of record 1923-35; 1939-date, 39 years
Drainage area 222 square miles

Obstruction to Stream Flow. Quarrying operations which are conducted below the gage have resulted in a gradual lowering of the control, the streambed and a shifting in the stream flow rating. During high water, loose rock and gravel shift downstream filling the pits created by the gravel company and at times lodging on the control. The location of the gaging station is shown on Exhibit 14-7.

Water losses. Rainfall and stream flow data indicate that infiltration losses may approach zero during severe winter-type storms and may be as low as 0.05 inch per hour during exceptional summer-type storms.

Flood Records. There is no information on floods in the Whiteoak Creek Basin prior to the establishment of the stream flow gage near Georgetown in 1923. Data relative to high stages recorded at this station since 1923 are listed in Table 14-7. Several outstanding floods are discussed in subsequent paragraphs.

Observed Storms and Floods. There are no official records of past floods occurring prior to 1923 and between the years 1935 and 1939. The greatest flood since measurement of discharges began occurred in March 1964. A comprehensive account is given in the following paragraphs for the storms and floods of March 1964, May 1933 and January 1937.

TABLE 14-7

HIGH WATER DATA
WHITEOAK CREEK NEAR GEORGETOWN, OHIO

(Channel capacity stage, 7.4 Ft.1/)

Date	Gage height feet1/	Discharge, c.f.s.	Duration days2/
10 Mar 1964	14.64	22,400	1.87
14 May 1933	13.90	20,500	1.50
20 Mar 1943	13.70	20,000	1.69
6 Mar 1945	13.10	18,600	1.21
12 Apr 1948	12.40	16,600	2.04
8 May 1961	12.34	16,400	2.25
5 Mar 1963	11.94	15,200	2.00
14 Feb 1948	11.83	14,900	1.33
17 Jun 1946	11.64	14,100	1.19
5 Apr 1957	11.54	14,000	1.33
22 Jan 1937	11.30 3/	13,300 3/	5.54 3/
27 Feb 1945	11.30	13,300	0.95
2 Aug 1958	11.20	13,000	0.33
5 Jan 1949	11.10	12,700	1.16
31 Dec 1923	11.00	12,400	0.60
27 Feb 1962	11.00	12,400	2.70
20 Apr 1940	11.00	12,400	0.67
22 Jan 1959	10.80	11,800	1.79
11 Mar 1935	10.70	11,500	2.00
22 Feb 1945	10.70	11,500	0.75
15 Jan 1951	10.64	11,300	1.50
9 Feb 1950	10.60	11,200	1.33
16 Mar 1948	10.54	11,000	1.00
3 Jan 1951	10.50	10,900	0.80
24 Jul 1965	10.43	10,700	0.57
15 Dec 1948	10.36	10,500	1.21
8 Nov 1925	10.28	10,300	0.92
24 Jan 1949	10.24	10,200	1.42
4 Apr 1950	10.24	10,200	1.33
20 Sep 1950	10.24	10,200	2.92
31 Jul 1958	10.20	10,100	0.92
28 Jan 1949	10.08	9,800	0.88
4 Apr 1931	10.08	9,800	0.83
3 Mar 1940	10.00	9,600	1.13

1/ Present site, datum and conditions. Rating Table No. 13 dated 27 January 1967. Stages may differ from actual recorded readings because of changes in sites or ratings.

2/ Duration above channel capacity, stage 7.4 feet

3/ Estimated

Storm and flood of March 1964. The occurrence of two distinct storms in March produced the highest known flood on Whiteoak Creek. The first storm began during the night of 3 March and continued without interruption through the following night. Rainfall amounts over Whiteoak Creek Basin averaged over four inches and flood flows from this storm had barely begun to recede when on 8 March, a second and more intense storm moved over the basin. During the next 50-hour period, an estimated average of 6.5 inches of rainfall was released over the basin. Ripley, Ohio, located near the center of the storm, recorded 8.10 inches during the 50-hour period. Flood flows produced a crest stage of 14.64 feet at Georgetown gage with a corresponding crest flow of 22,400 c.f.s. The volume of runoff from the area above the Whiteoak site was approximately 5.1 inches.

Storm and flood of May 1933. The flood of May 1933 is the second largest flood of record on Whiteoak Creek near Georgetown. Precipitation occurred daily from the 1st to the 16th over the southern portion of Ohio. Cincinnati had the greatest amount in any 24 consecutive hours, 4.77 inches on the 13th and 14th. This storm moved from the southwest at approximately 30 miles per hour and reached Whiteoak Creek Basin on the 13th. The maximum stage recorded at Georgetown was 20.87 feet (13.9 feet, present datum) and corresponded to a stream discharge of 20,500 cubic feet per second, as estimated by the United States Geological Survey. The volume of runoff from Whiteoak Creek watershed was approximately 3.7 inches.

Storm and flood of January 1937. A series of abnormally heavy rains began late in December 1936 and continued early through January 1937, with climatic intensities in the period January 20 to 25 centered largely in the middle and lower portions of the Ohio River Valley, causing floods in the Ohio and mid-Mississippi Valleys that were greater than any previously known. On the Ohio River at Cincinnati, Ohio, the flood crest was about four feet higher than the 1773 flood, the highest previously reported. Whiteoak Creek at Georgetown reached an estimated stage of 11.30 feet on the 22nd of January, equal to a flow of 13,300 c.f.s. The January 1937 flood produced four distinct rises from the 14th to the 26th of January which were above flood stage for a total of 5.54 days. The volume of runoff from the Whiteoak Creek watershed was approximately 9.92 inches for the period 14-26 January 1937. Hydrographs of the flood of January 1937 are shown on Exhibit 14-8.

Flood probabilities and frequencies. A study of the probable frequency of occurrence of floods of varying magnitude has been made for Whiteoak Creek near Georgetown. The record of the station demonstrates that floods may occur in any month of the year. The frequency of flooding analysis for the Georgetown gage was developed using procedures outlined in "Statistical Methods in Hydrology," by Leo R. Beard, dated January 1962, and published by the Chief of Engineers. The analysis was based on stream flow records at Georgetown. The estimated frequencies of various stages and discharges for Whiteoak Creek near Georgetown are given in Table 14-8. The frequency of flooding analysis also complies with instructions contained in Water Resources Council Bulletin No. 15, "A Uniform Technique for Determining Flood Flow Frequency."

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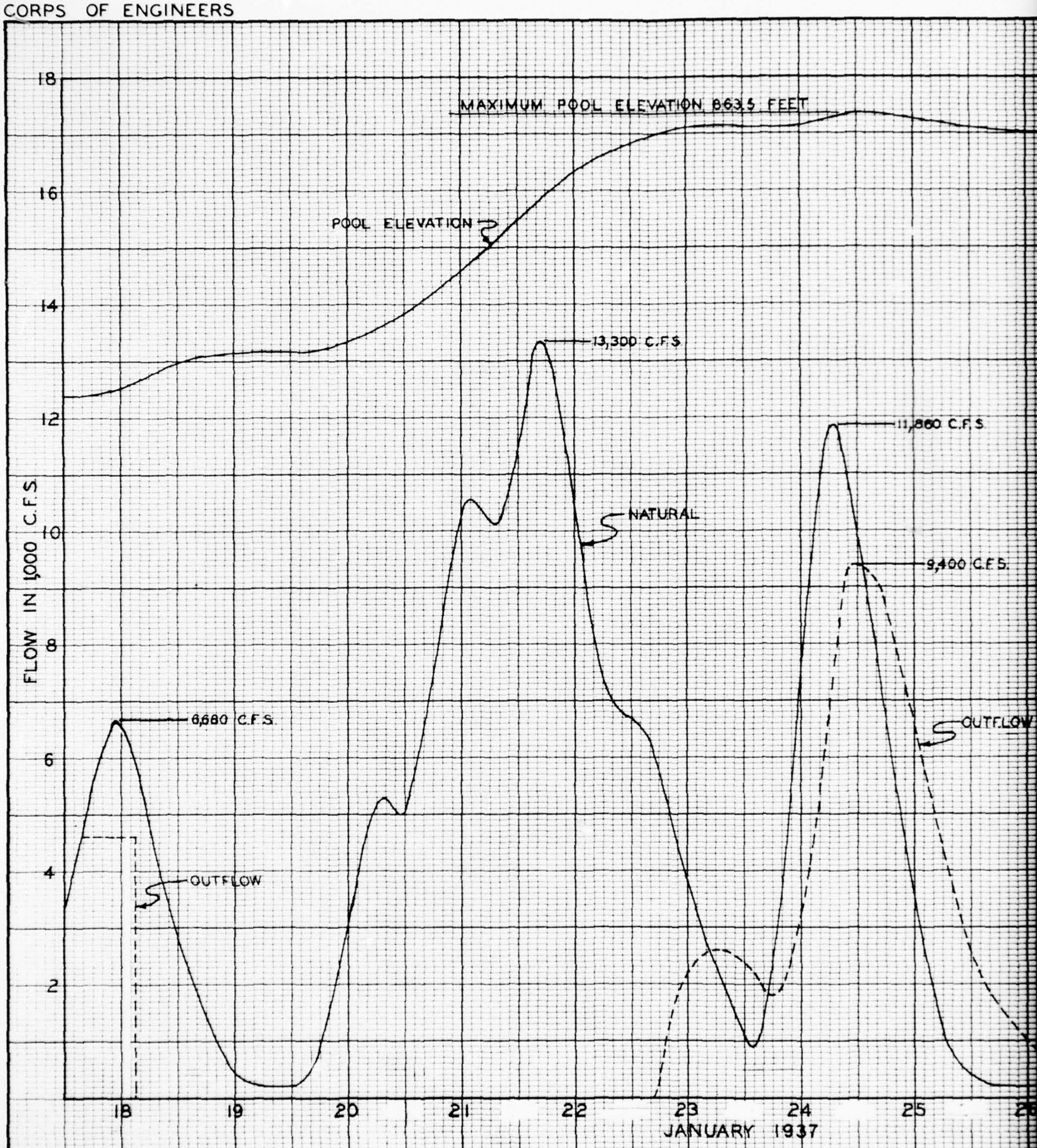

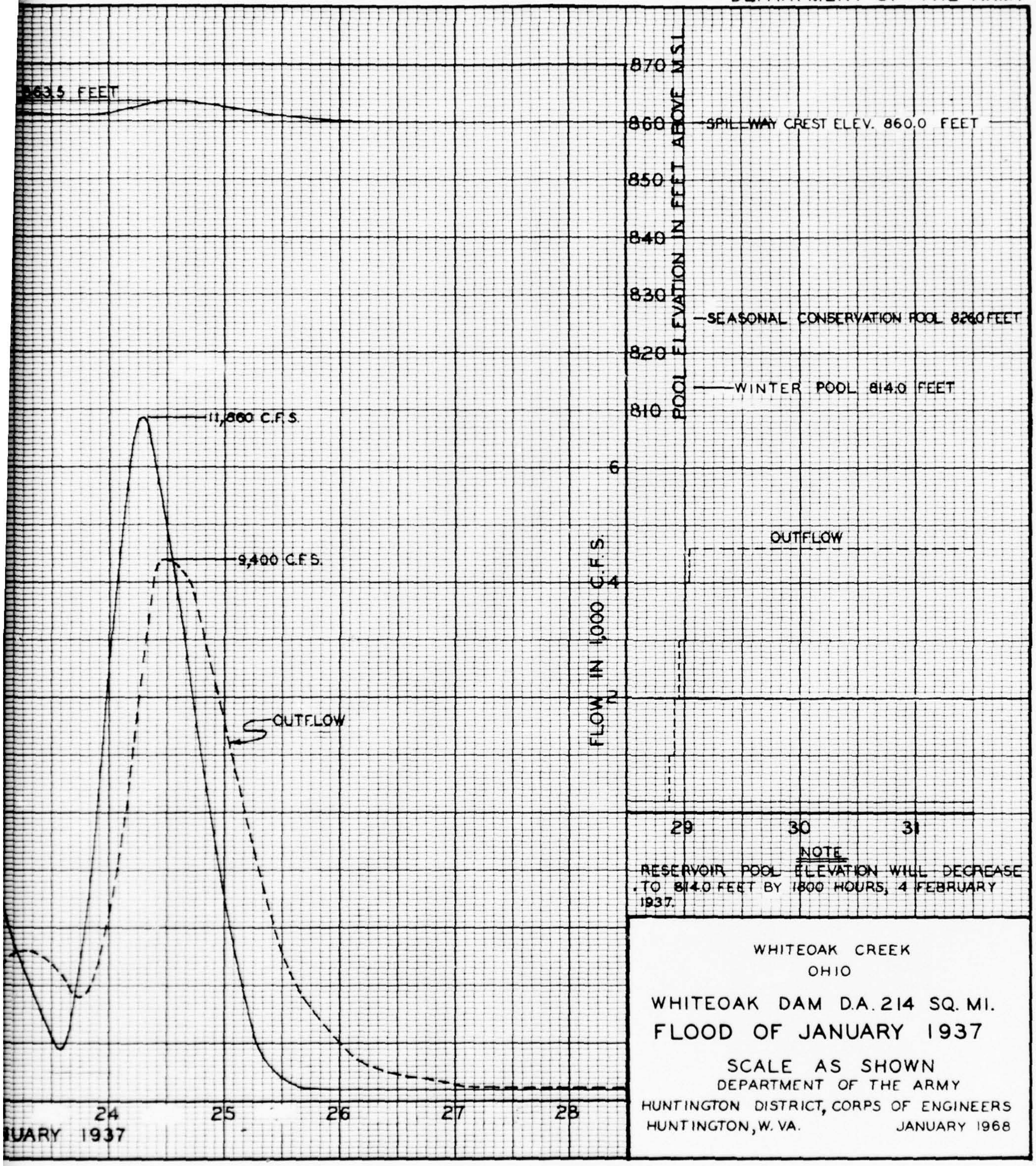

WHITEOAK CREEK
OHIO

WHITEOAK DAM D.A. 214 SQ. MI.

FLOOD OF JANUARY 1937

SCALE AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. JANUARY 1968

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TABLE 14-8

STAGE AND DISCHARGE FREQUENCIES
WHITEOAK CREEK NEAR GEORGETOWN, OHIO

Exceedence interval, years	Natural flow, c.f.s.	Natural stage, feet 1/
100	26,800	16.3
50	23,800	15.2
30	21,600	14.3
10	17,200	12.6
5	15,100	11.9
3	13,600	11.3
1	10,000	10.2

1/ U.S.G.S. gage, zero = 569.21 feet above m.s.l.

Ohio River frequency of flooding. Frequency curves for 22 locations on the main stem of the Ohio River for both natural and modified discharge and stage are presented in "Ohio River Comprehensive Survey Report." These curves were used as a basis for the determination of benefits along the Ohio River. Frequencies for a typical reach along the Ohio River are presented in Table 14-9. The natural frequency of flooding as modified by projects in existence, under construction, and in the advanced planning stage was further modified by Whiteoak Reservoir Project at each downstream damage center on the Ohio River. Modified frequency stages at Cincinnati, Ohio, for Whiteoak Reservoir Project are listed in Table 14-9.

TABLE 14-9

STAGE FREQUENCIES FOR OHIO RIVER
AT CINCINNATI, OHIO

Exceedence interval (years)	Natural stage (feet)	Modified stage 1/ (feet)	Natural modified by Group "A" Reservoirs and Whiteoak Reservoir (feet)	Whiteoak Reservoir reductions (feet)
100	76.99	69.58	69.51	.07
50	73.62	66.28	66.21	.07
20	68.75	61.58	61.50	.08
10	64.54	57.70	57.62	.08
5	59.73	53.52	53.44	.08
2	52.18	47.16	47.08	.08
1	45.06	41.85	41.79	.06

1/ Natural as modified by Group "A" Reservoirs (existing, under construction or in advanced planning status, FY 65)

Standard Project Storm and Flood for Whiteoak Dam and Reservoir Project. The purpose and scope of this section is to present detailed data on the hypothetical storms and floods critical to the hydraulic design of a multiple purpose reservoir considered in Whiteoak Creek Basin. The Standard Project Storm and Flood for the proposed multiple-purpose project in the Whiteoak Creek Basin is based on generalized rainfall criteria for small drainage basins east of 105 degrees longitude. Analysis of the seasonal variation of the generalized estimates of rainfall and of the possible snow cover over the basin indicated that a summer-type storm is more severe than a winter-type. Therefore, a summer-type storm was adopted. A review of summer-type storms indicates that a minimum infiltration rate of 0.05 inch per hour may be experienced. This value was adopted in determining the storm rainfall excess. Studies of stream-flow records in Whiteoak Creek Basin indicate a base flow of approximately one c.f.s. per square mile, the value adopted for the present study. Seasonal pool elevation 826.0 was assumed at the onset of the flood. Natural, inflow, and outflow hydrographs, and reservoir pool elevations are shown on Exhibit 14-9. Pertinent data are given in Table 14-10.

TABLE 14-10

STANDARD PROJECT STORM AND FLOOD
WHITEOAK RESERVOIR PROJECT

SUMMARY

Drainage area in square miles	214.0
Rainfall in inches	14.97
Losses in inches	3.16
Excess in inches	11.81
Natural peak discharge, c.f.s.	69,300
Natural peak discharge, c.f.s. per square mile	324
Regulated peak discharge, c.f.s.	51,200
Reduction in c.f.s.	18,100
Flood comparison:	
Max. flood of record (March 1964), % S.P.F.	32.4
Summer-type design flood, % S.P.F.	38.8
Spillway Design Flood - summer-type in % of S.P.F.	193.3

Maximum controlled storm and flood for Whiteoak Dam and Reservoir Project. Allocated flood control storage in Whiteoak Reservoir Project was determined by a hydrologic analysis of selected representative floods and utilization of low, medium and high increments of storage. Optimum performance-cost efficiency indicate an allocation of 43,700 acre-feet for seasonal flood control storage and 53,800 acre-feet for winter flood control storage. Using the reservoir capacity which could be provided up

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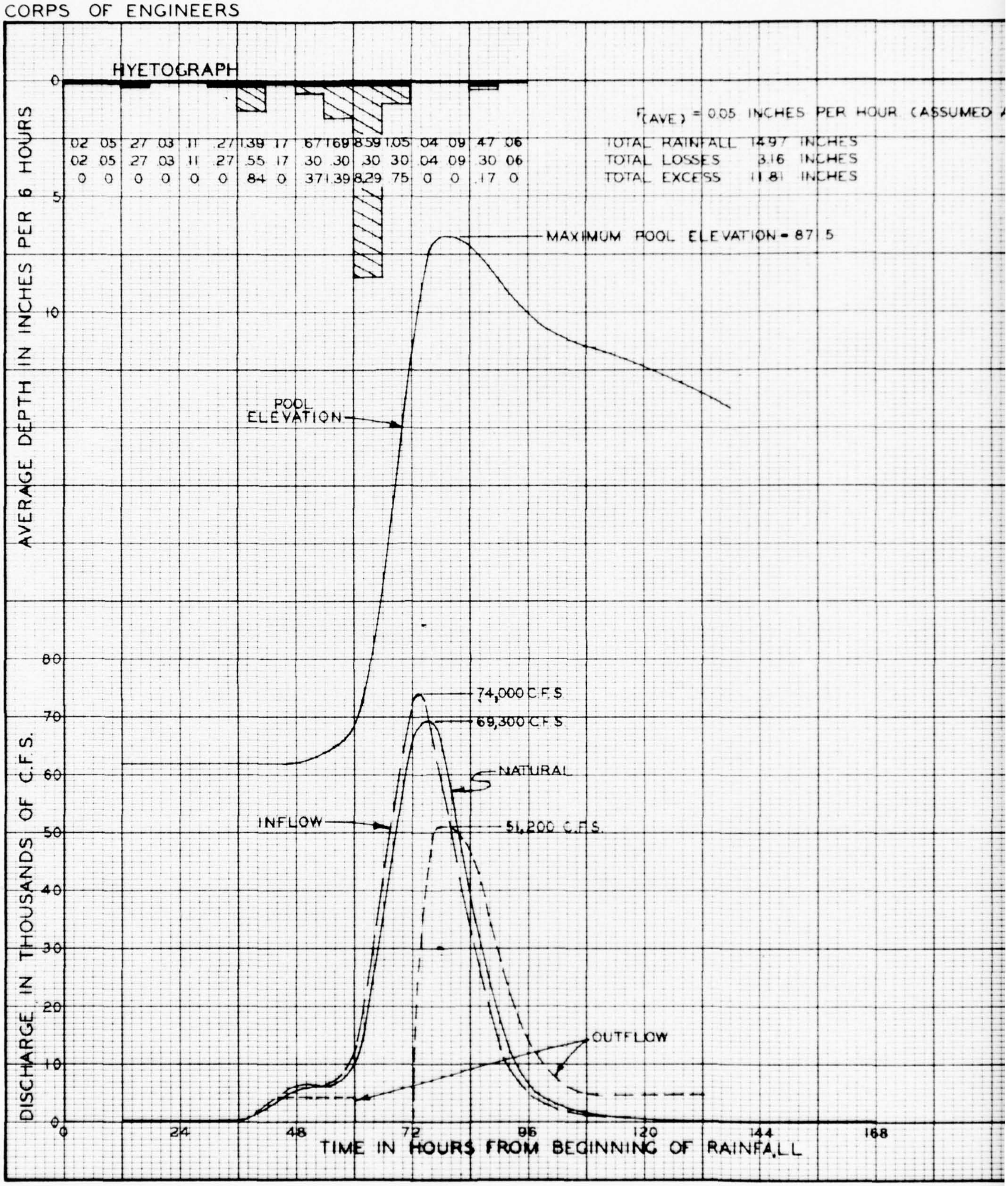
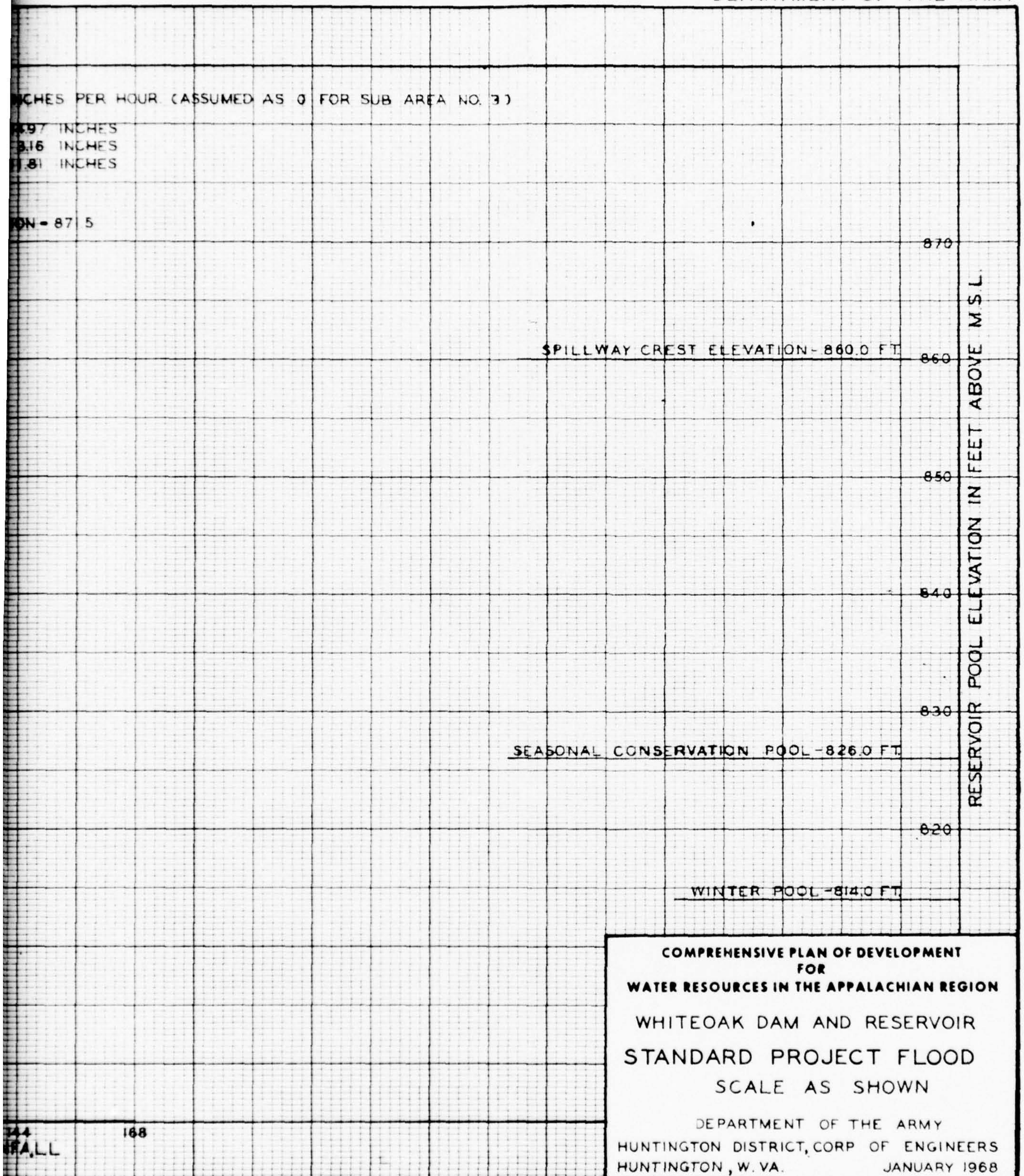


DEPARTMENT OF THE ARMY



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

STANDARD PROJECT FLOOD

SCALE AS SHOWN

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HUNTINGTON DISTRICT, CORP OF ENGINEERS
HUNTINGTON, W. VA. JANUARY 1968

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to maximum flood-control pool, the Standard Project Flood, which would result from a summer-type storm, was reduced to that flood which could be controlled by the reservoir. Pertinent data are given in Table 14-11.

TABLE 14-11

WHITEOAK RESERVOIR MAXIMUM CONTROLLED
STORM AND FLOOD SUMMARY

Drainage area, square miles	214.0
Rainfall, inches	6.95
Losses, inches	2.48
Excess, inches	4.47
Natural peak discharge, c.f.s.	26,890
Natural peak discharge, c.f.s. per square mile	125.7
Regulated peak discharge, c.f.s.	4,600
Reduction, c.f.s.	22,290

Spillway Design Storm and Flood. The spillway design storm and flood estimates were prepared in accordance with EM 1110-2-1405. Hydrometeorological Report No. 33, prepared by the United States Weather Bureau, dated April 1956, presents estimates of the seasonal variation of the probable maximum precipitation east of the 105th meridian for areas up to 1,000 square miles and durations up to 48 hours. Spillway design flood inflow hydrographs were constructed which represent the critical volume and concentration of runoff into the reservoir under the most extreme conditions considered reasonably possible.

Probable Maximum Precipitation. Hydrometeorological Report No. 33 presents estimates of probable maximum rainfall values for a sufficient number of areas and durations to permit interpolation of estimates applicable to areas up to 1,000 square miles. The probable maximum precipitation represents the critical depth-duration-area rainfall relations for a particular area during various seasons of the year that would result if conditions during an actual storm in the region were increased to represent the most critical conditions that are considered probable of occurrence. Analysis of the seasonal variation of the maximum probable rainfall and of the possible snow cover over the basins indicate that the summer-type storms are more severe than the winter-type storms. The 24-hour rainfall values were arranged in the most critical order and the 6-hour values within each 24-hour period were further arranged in the most critical order. There is no implied isohyetal pattern. Rainfall values obtained from HMS Report No. 33 were reduced by 10.95 percent in accordance with criteria

presented in Engineer Circular No. 1110-2-27, dated 1 August 1966. The average rainfall values over the watershed above the flood-control dam are shown in Table 14-12.

TABLE 14-12

PROBABLE MAXIMUM PRECIPITATION AND RUNOFF
WHITEOAK RESERVOIR PROJECT

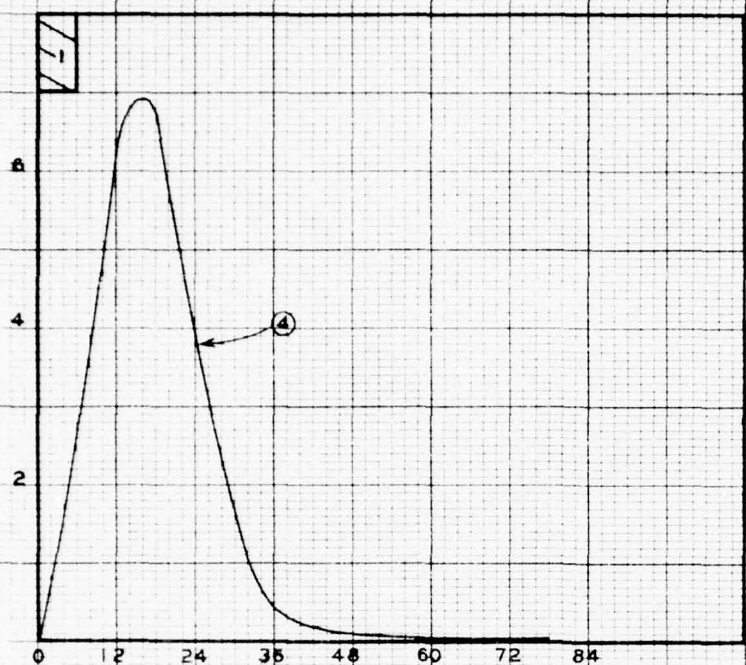
Six-hour period No.	Rainfall, inches	Losses, inches	Rainfall excess, inches (R_e)	Duration of R_e in hours
1	.53	.53	0	0
2	.53	.53	0	0
3	.55	.30	.25	6
4	.65	.30	.35	12
5	1.44	.30	1.14	18
6	3.62	.30	3.32	24
7	16.15	.30	15.85	30
8	1.01	.30	.71	36
Totals	24.48	2.86	21.62	

Runoff factor = 88.3%   Infiltration rate = 0.05 inches per hour

Unit Hydrograph Development for Spillway Design Flood. The formation of a long reservoir in a natural drainage basin may materially alter the regimen of flood runoff by synchronizing high rates of runoff originating above the head of the reservoir with maximum flow rates from areas contributing laterally to the reservoir. The time required for flood waves to traverse the natural channel within the limits of the proposed reservoir is several hours. The time required for inflow into the upper end of the full reservoir to become effective at the point of reservoir outflow ranges from practically zero to about one hour. For the purpose of this report, zero time of travel is assumed in all cases. The critical rate of inflow into a full reservoir during the spillway design storm was estimated for the proposed project by dividing the drainage area contributing to the full reservoir into three sub-areas; namely (1) principal tributaries (2) minor sub-areas immediately adjacent to the reservoir, and (3) the reservoir surface. Unit hydrographs were derived for the respective sub-areas using such hydrologic data as was available, supplemented by synthetic unit hydrograph computations. The rate of runoff from the reservoir surface was taken as equal to the rate of rainfall. Exhibit 14-10 shows the unit hydrographs used in developing spillway design flood criteria for the project.

Hypothetical Hydrographs of Runoff from Spillway Design Storm. Hydrographs were prepared for a provisional spillway design flood,

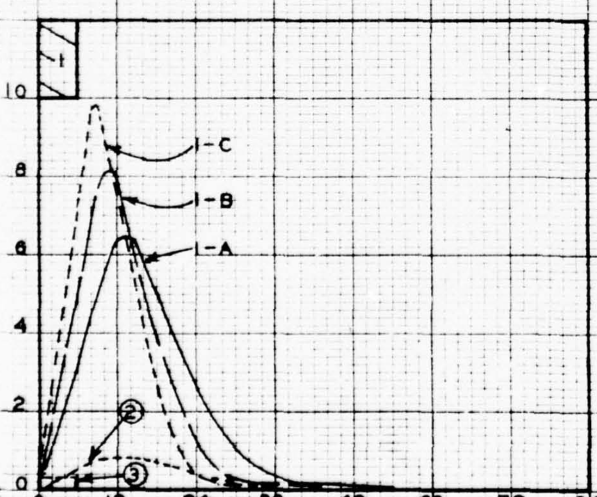
DISCHARGE IN THOUSANDS OF CUBIC FEET PER SECOND



TIME IN HOURS FROM BEGINNING OF RAINFALL EXCESS
UNIT HYDROGRAPH FOR DAM SITE UNDER NATURAL CONDITIONS

UNIT HYDROGRAPH TABULATION

TIME IN HOURS	INSTANTANEOUS DISCHARGE IN CFS AT TIME DESIGNATED				
	1-A	1-B	1-C	2	4
6	3066	4920	7050	427	2681
12	6300	7879	7569	828	6336
18	5046	4020	2834	756	6736
24	2757	1322	396	432	3905
30	1058	280	168	199	1735
36	264	140	76	49	434
42	121	80	56	20	178
48	83	46	12	13	116
54	51	25	0	8	65
60	37	1		5	46
66	24	0		4	37
72	8			2	17
78	0			0	0

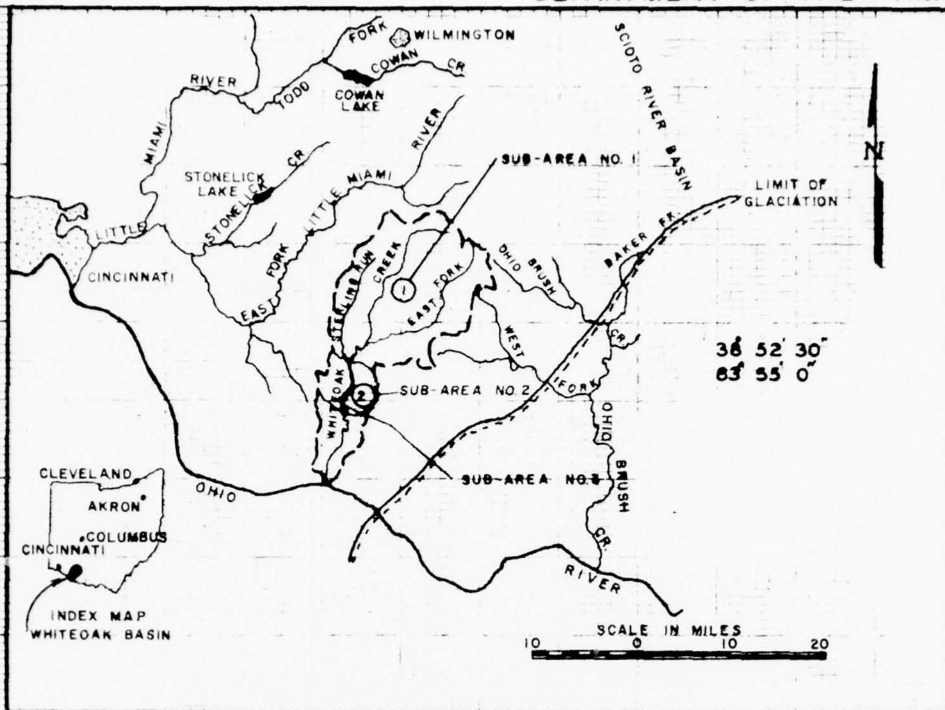


TIME IN HOURS FROM BEGINNING OF RAINFALL EXCESS
UNIT HYDROGRAPHS FOR SUB-AREAS CONTRIBUTING TO FULL RESERVOIR

...DROGRAPH TABULATION

...NTANEOUS DISCHARGE IN C.F.S. AT TIME DESIGNATED

1-B	1-C	2	4
4920	7050	427	2681
7879	7569	828	6336
4020	2834	756	6736
1322	396	432	3905
280	168	199	1735
140	76	49	434
80	56	20	178
46	12	13	116
25	0	8	65
		5	46
0		4	37
		2	17
		0	0



LOCATION MAP

DATA RELATING TO UNIT HYDROGRAPH

NO.	UNIT DURATION IN HOURS	AREA REPRESENTED IDENTIFICATION	SQ. MI.	REMARKS
1-A	6	SUB-AREA NO. 1	186.1	AREA AT HEAD OF RESERVOIR
1-B	6	" " "	"	ALTERNATE TO 1-A, PEAK 125% OF 1-A
1-C	6	" " "	"	" " " " 150% " "
2	6	" " NO. 2	25.1	ESTIMATE FOR SUM OF SMALL AREAS
3	6	" " NO. 3	2.8	RATE OF RUNOFF = RAINFALL INTENSITY
4	6	TOTAL AT DAM	214	FOR NATURAL RIVER CONDITIONS

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

UNIT HYDROGRAPHS USED IN DEVELOPING SPILLWAY DESIGN FLOOD CRITERIA

U.S ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA. JANUARY 1968

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corresponding to the spillway design storm rainfall-excess quantities as follows: (1) the runoff from the area above the dam site under natural river conditions, and (2) the runoff into a full reservoir, reflecting the effect of the reservoir in modifying the regimen of runoff. Inflow hydrographs were also prepared representing greater configuration of runoff but having the same volume as the provisional spillway design flood inflow hydrograph. Exhibit 14-11 shows the various hydrographs of runoff from the spillway design storm and the spillway design flood inflow hydrograph proposed for adoption for the reservoir.

Adopted Spillway Capacity. The spillway capacity is based on a spillway design flood inflow hydrograph which is assumed to reflect all factors of safety necessary to assure a safe estimate of the maximum reservoir level that would result from the adopted size and type of spillway and the proposed method of operation. The maximum reservoir inflow for the adopted spillway design flood is 165,000 cubic feet per second. The maximum spillway discharge resulting from this flood was 149,900 cubic feet per second. The initial reservoir level was assumed to be at maximum flood-control level at the onset of the spillway design flood.

Unit Hydrographs. Unit hydrographs were derived for Whiteoak Creek near Georgetown by the most direct method of analysis of records of runoff resulting from a storm which produced reasonably uniform rainfall-excess rates. Exhibit 14-12 shows the storm analyzed and Exhibit 14-13 is a tabulation of the unit hydrograph ordinates. Synthetic unit hydrographs were constructed as required and these served as a substitute for derivations from hydrologic records.

Area and Capacity Curves. The areas for various elevations of Whiteoak Reservoir were determined from United States Geological Survey topographic maps with a scale of 1:24,000 and contour intervals of 5-, 10- or 20-feet, depending upon the topography. Areas at other elevations were interpolated in order to compute capacities for the derivation of the area-capacity curves shown on Exhibit 14-14.

Reservoir pools. Data on the reservoir pools are shown in Table 14-13.

Plan of Reservoir Regulation. Any reservoir or group of reservoirs in Whiteoak Creek Basin must be considered as part of an integrated reservoir system in the Ohio River Basin. Since Whiteoak Reservoir Project is to be included as part of a larger system, the method of reservoir regulation must be correlated with the operation of other reservoirs in the system for the purpose of obtaining optimum performance from the entire system. Consistent with the foregoing statement, a plan of reservoir regulation has been established for

Whiteoak Reservoir which provides a reliable index of the benefits resulting from the operation of existing projects in conjunction with proposed projects. In addition to overall system requirements, full consideration has been given to local requirements immediately below the project. The adopted plan of reservoir operation is based on the assumption that an adequate flood forecasting and warning system would be in operation at all times. The single reservoir project proposed in Whiteoak Creek Basin is for flood control, water supply, water quality control, fish and wildlife enhancement, general recreation and economic expansion.

TABLE 14-13

WHITEOAK DAM AND RESERVOIR PROJECT
RESERVOIR POOL DATA

Pool	Surface elevation, feet, m.s.l.	Incremental Capacity acre-feet net	Accum.	inches net	accum.	Area, acres	Backwater, main stream, miles
Minimum	786	9,500	9,500	0.8	0.8	320	4.4
Winter	814	14,900	24,400	1.3	2.1	741	6.6
Seasonal	826	10,100	34,500	0.9	3.0	931	7.5
Flood Control							
Seasonal	860	43,700	78,200	3.8	6.8	1,764	11.2
Winter	860	53,800	78,200	4.7	6.8	1,764	11.2
Total	860	78,200	78,200	6.8	6.8	1,764	11.2

See page 57 for storages allocated to water supply and water quality control.

Flood control operation would be primarily for the Ohio River with reservoir releases being limited to the Whiteoak Creek downstream capacity of 4600 c.f.s. The gates would be closed and all reservoir inflow stored for Ohio River control 36 hours before a predicted crest stage of 50.0 feet (elevation 493.0) on the lower gage at Captain Anthony Meldahl Locks and Dam. The gates would remain closed until the Ohio River at Meldahl had crested, fallen one foot and further recession was indicated as determined by ESSA forecasts. At the end of the regulation period, reservoir releases would gradually be increased by 1,000 c.f.s. increments up to channel capacity of 4,600 c.f.s and maintained at that rate until flood storage is released or until Ohio River flood conditions require further reservoir operation.

Determination of storage yield relationships is one of the basic technical activities associated with the study of low flow regulation in multiple purpose reservoir projects. Since Whiteoak Reservoir is in this category, it was necessary to determine required storages for

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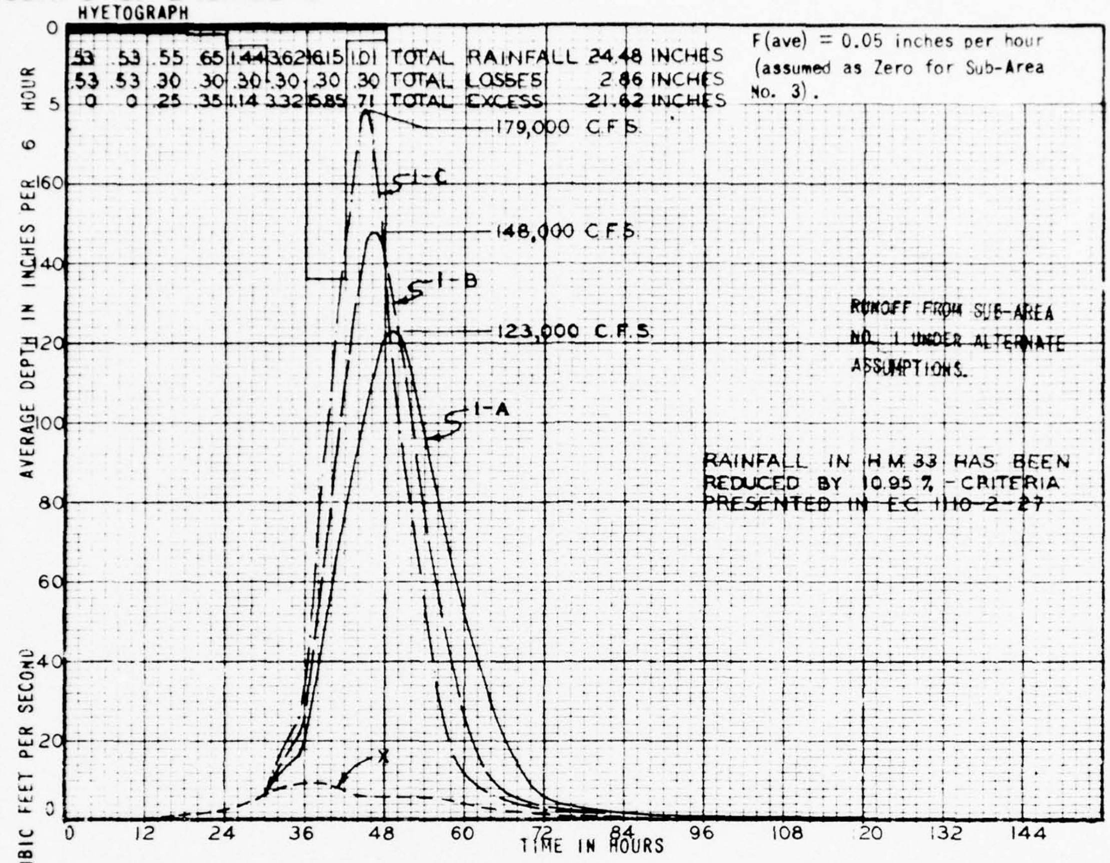

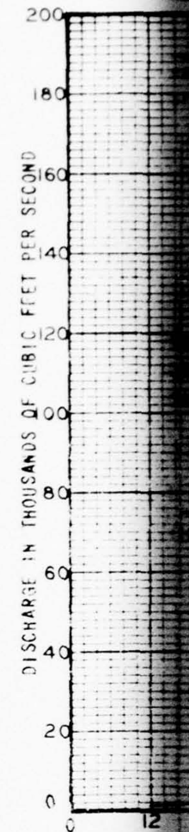

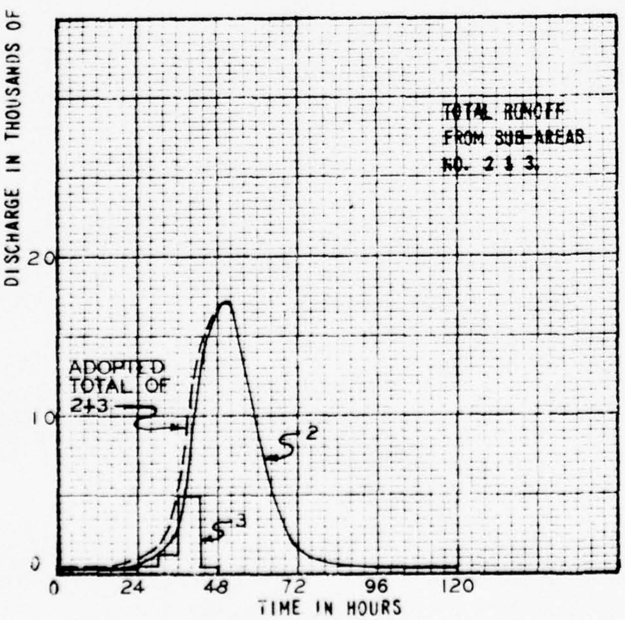

DATA RELATED TO HYPOTHETICAL HYD

HYDRO-GRAPH NO.	AREA REPRESENTED		UNIT GRAPH	REM
	SUB-AREA	SQ. MI.		
X	No. 1	186.1	1-A	Runoff from design storm, exclus
*1-A	"	"	"	Hydrograph "X" + runoff from 2 Max
1-B	"	"	1-A; 1-B	" "
1-C	"	"	1-A & 1-C	" "
*2	No. 2	25.1	2	Summation of small areas adjacent
*3	No. 3	2.8	3	Reservoir surface.
*A	Total	214	-	Hydrograph No. 1-A + No. 2 + No. 3 reservoir.
**B	"	"	-	Hydrograph No. 1-B + No. 2 + No. 3 reservoir.
C	"	"	-	Hydrograph No. 1-C + No. 2 + No. 3 reservoir.
*D	"	"	-	Represents flow at dam site under

**Selected as "Spillway Design Flood."

*Represents "Provisional Spillway Design Flood" runoff under condi

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Sub-Area

SUB-AREA
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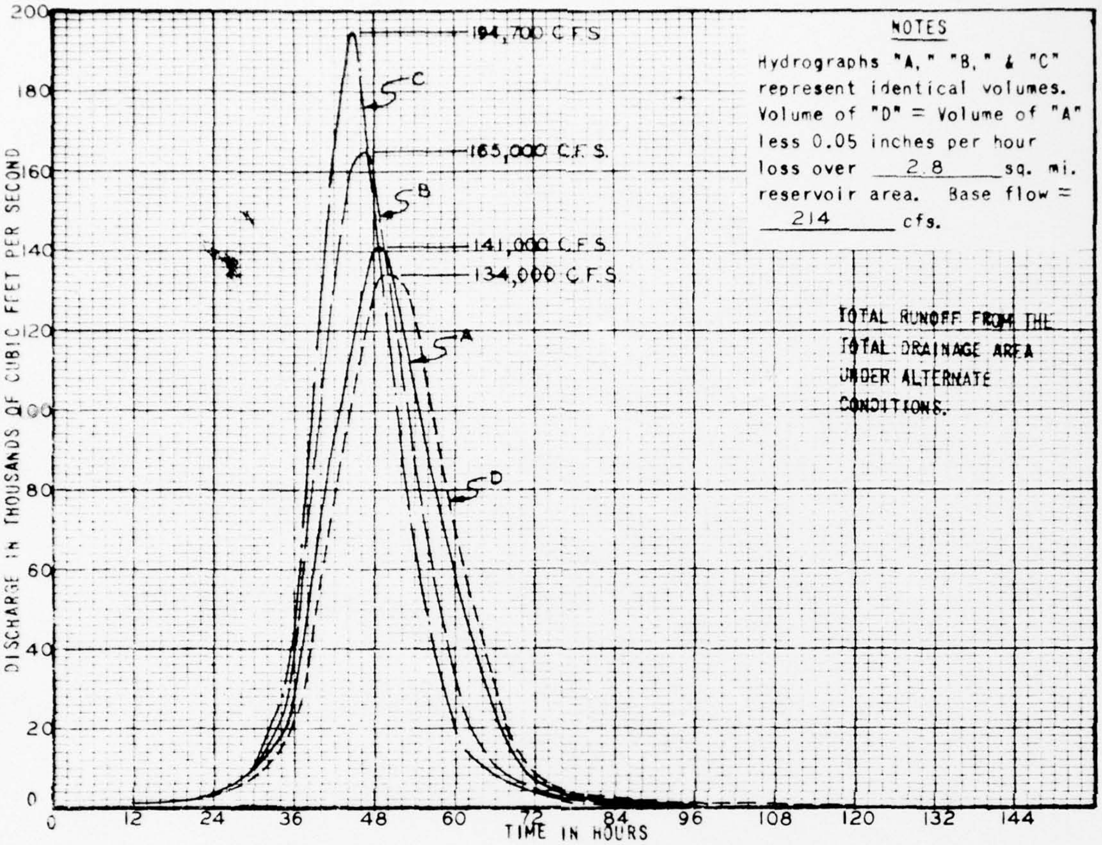

NOTES

Hydrographs "A," "B," & "C" represent identical volumes. Volume of "D" = Volume of "A" less 0.05 inches per hour loss over 2.8 sq. mi. reservoir area. Base flow = 214 cfs.

DATA RELATED TO HYPOTHETICAL HYDROGRAPHS

	REMARKS
	Runoff from design storm, exclusive of 2 Max 6 Hr. R_e (1917).
	Hydrograph "X" + runoff from 2 Max 6 Hr. R_e computed by U.G. 1-A.
-B	" " " " 1-B.
-C	" " " " 1-C.
	Summation of small areas adjacent to reservoir.
	Reservoir surface.
	Hydrograph No. 1-A + No. 2 + No. 3 represents inflow into full reservoir.
	Hydrograph No. 1-B + No. 2 + No. 3 represents inflow into full reservoir.
	Hydrograph No. 1-C + No. 2 + No. 3 represents inflow into full reservoir.
	Represents flow at dam site under natural conditions.

n Flood."
llway Design Flood" runoff under conditions and from areas designated.

NOTES

Rainfall amounts based on Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian."

Unit Hydrographs applied and listed in the Data Chart are shown on Exhibit G-17.

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

HYPOTHETICAL HYDROGRAPHS OF RUNOFF FROM SPILLWAY DESIGN STORM

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CORPS OF ENGINEERS
HUNTINGTON, W. VA. JANUARY 1968

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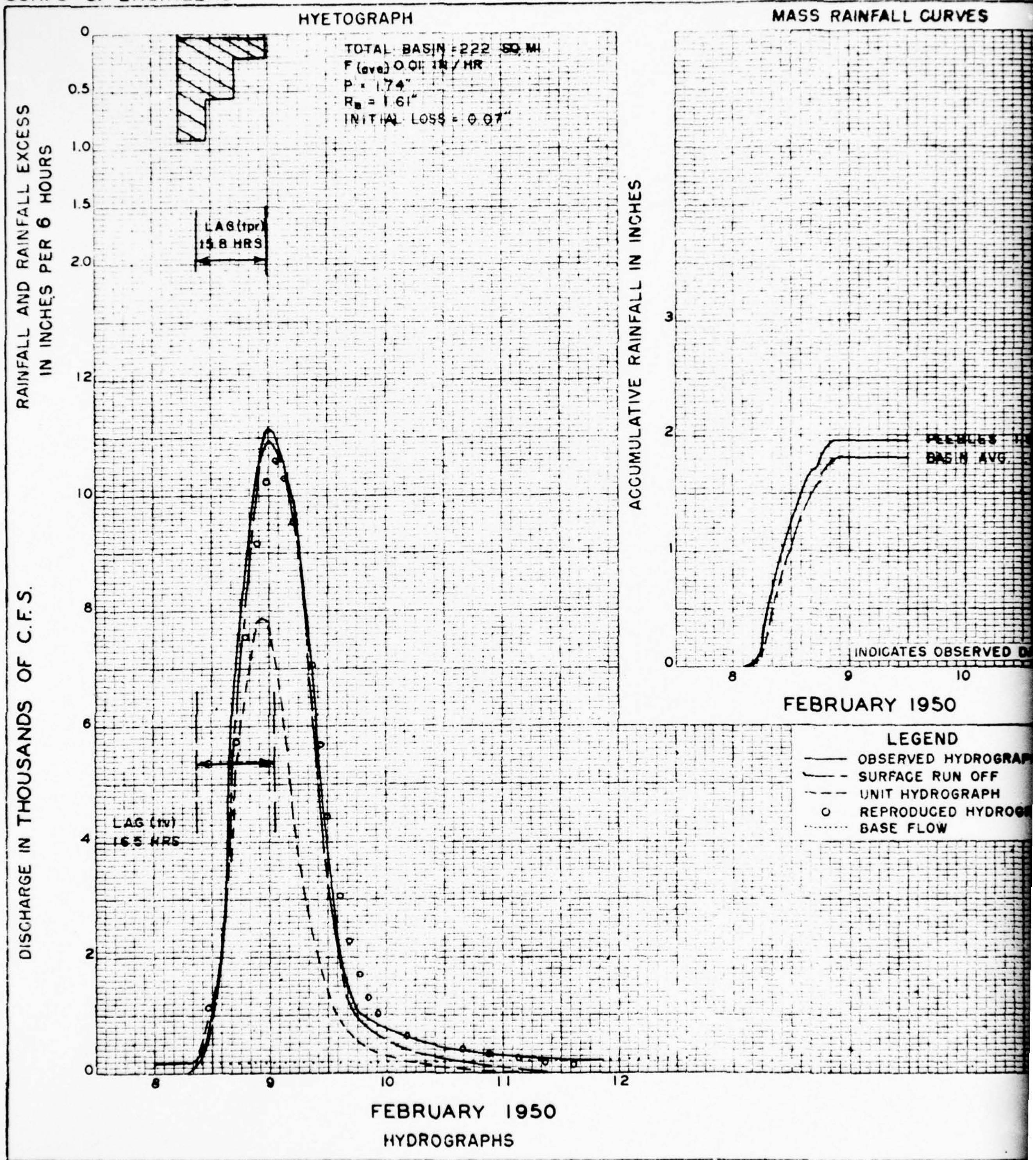

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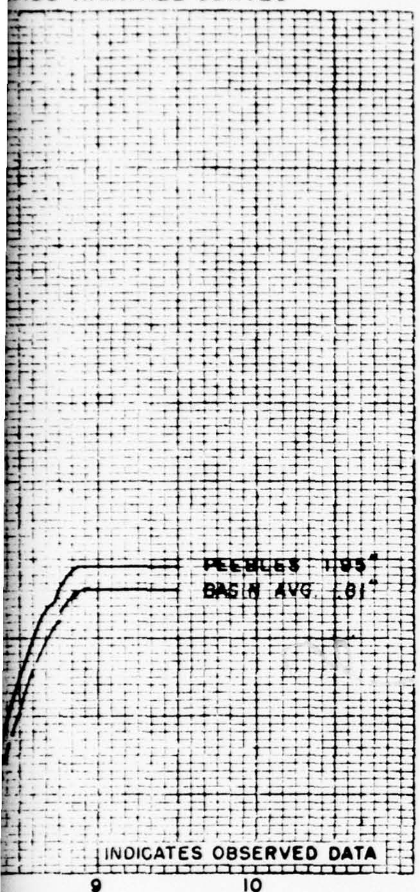
MASS RAINFALL CURVES

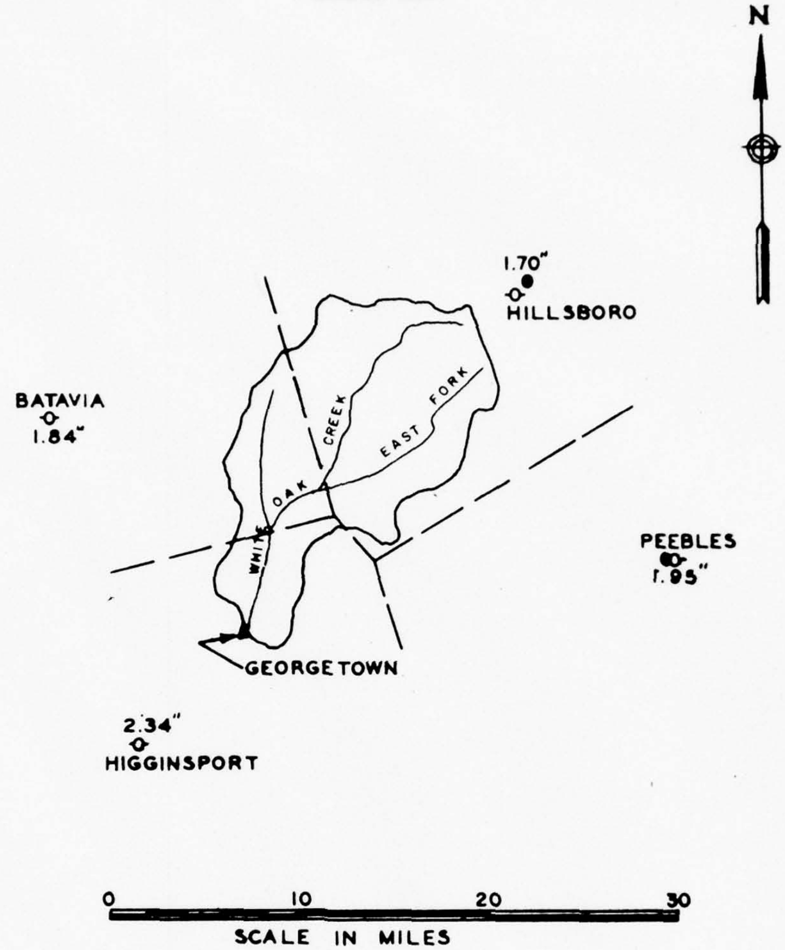


FEBRUARY 1950

LEGEND

- OBSERVED HYDROGRAPH
- SURFACE RUN OFF
- UNIT HYDROGRAPH
- REPRODUCED HYDROGRAPH
- BASE FLOW

BASIN MAP



LEGEND

	REC.	NON REC.
PRECIPITATION GAGES	●	○
STREAM GAGES	▲	△
ISOHYETS		
THIESSEN POLYGON		
ZONE BOUNDARY		
PRECIPITATION & TEMP		

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK CREEK
NR GEORGETOWN, OHIO

8-11 FEBRUARY 1950
UNIT HYDROGRAPHS

SUBMITTED BY
DISTRICT ENGINEER, HUNTINGTON DIST.

BASIC DATA
(Sheet 1 of 2)

EXHIBIT 14-12

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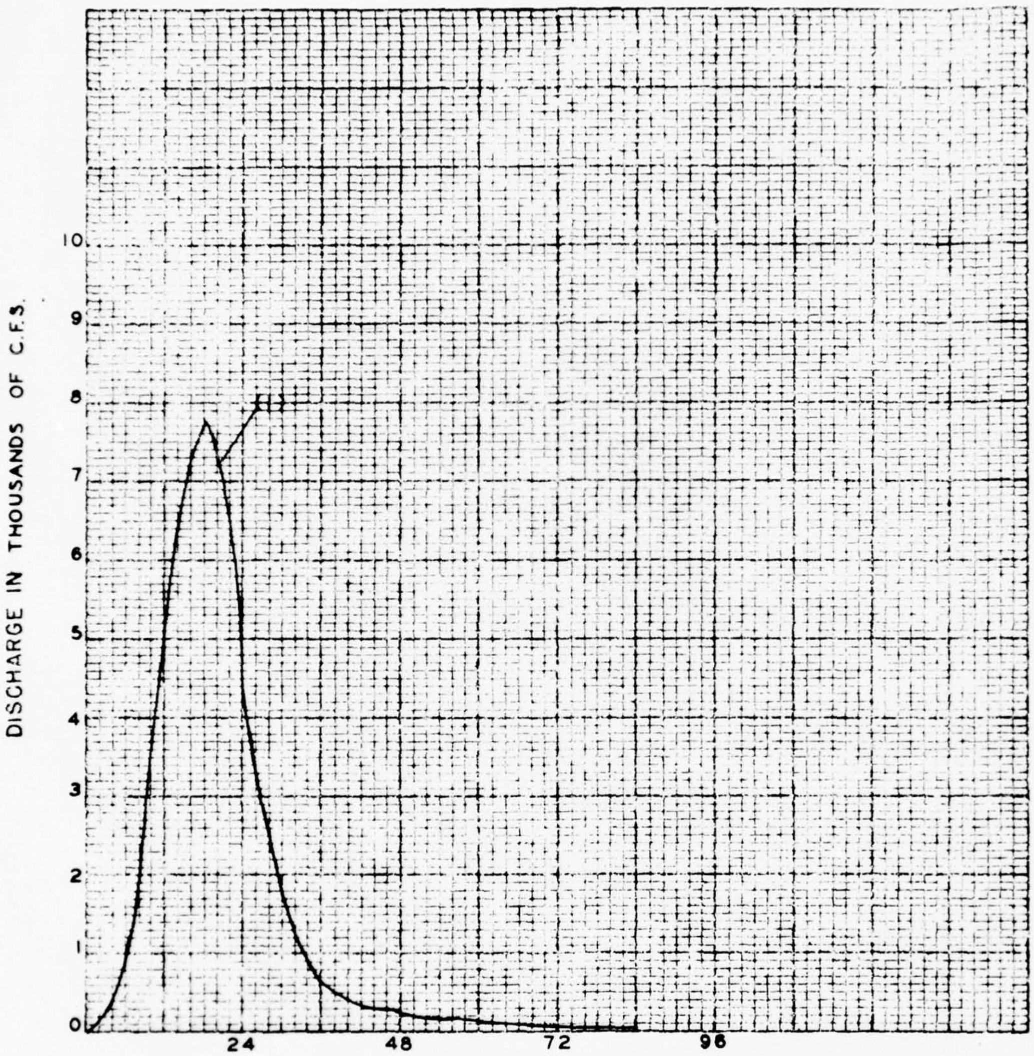
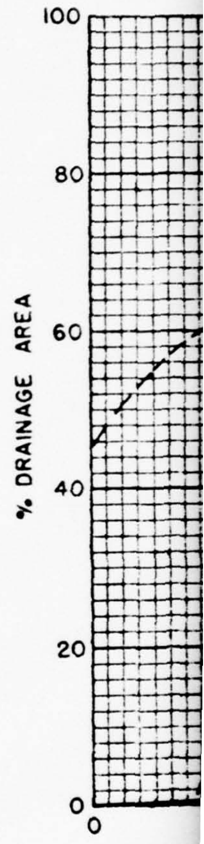
OBSERVED UNIT HYDROGRAPHS



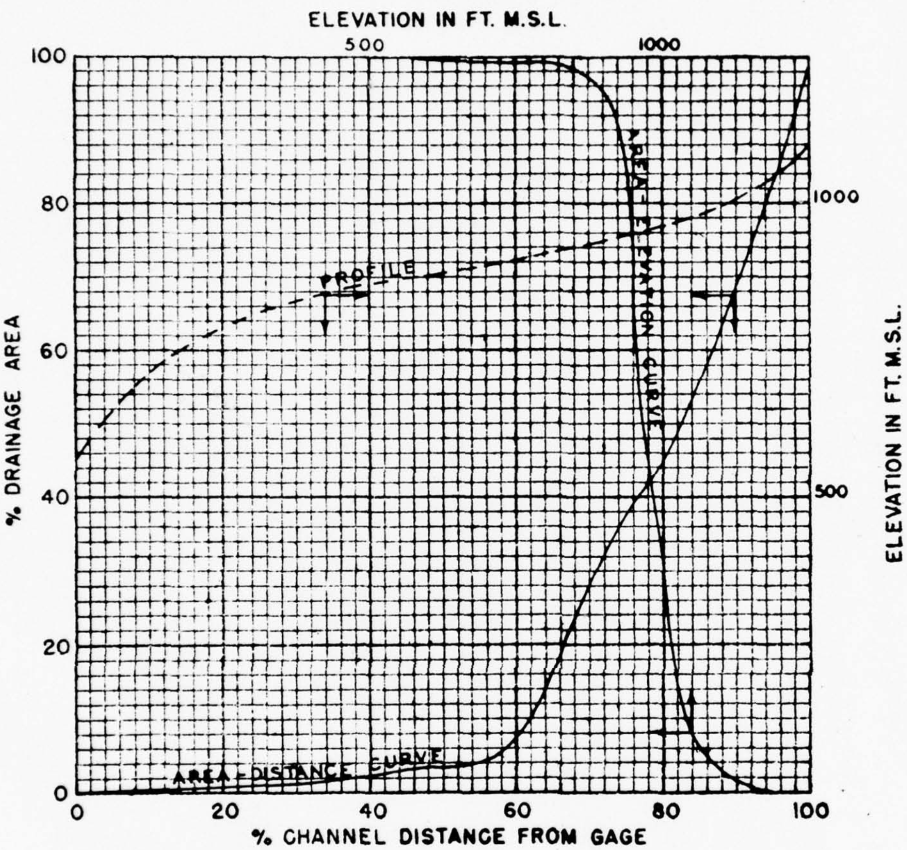
DRAINAGE AREA 2
MAXIMUM ELEVATION I
MINIMUM ELEVATION 5
MEAN ELEVATION (wei
LAND SLOPE 1
MAIN STREAM SLOPE



DATA FROM OBSERVED UNIT HYDROGRAPHS													
DATE OF RAINFALL	LEGEND	AVE. P (In.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (In.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (cfs.)	Q_p tr= hrs. (cfs.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_p64
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
8-10 FEB. 1950	——— (1)	1.74	6	1.61	UNIFO	R. 2 D	7.800	8220	15.8	15.0	16.5	1.87	557

DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	222	sq. mi.	L	40.0	mi.
MAXIMUM ELEVATION	1100	ft. m.s.l.	L_{ca}	26.1	mi.
MINIMUM ELEVATION	369.2	ft. m.s.l.	$(LL_{ca})^{0.3}$	8.05	
MEAN ELEVATION (weighted)	955.	ft. m.s.l.	DRAINAGE DENSITY	2.12	mi/sq.mi.
LAND SLOPE	160.	ft./mi.	MAP SCALE	1:62,500.	
MAIN STREAM SLOPE	8.87	ft./mi.	METHOD OF FLOW SEPARATION	TYPE A	
			BASIN SHAPE FACTOR	7.24	



RAPHS

Qp hrs. (cfs.)	tpR (hr.)	tp (hr.)	tv (hr.)	CtR	Cp640	Km (hr.)	Tc (hr.)
(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
220	15.8	15.0	16.5	1.87	557	7.4	18.5

Sheet 2 of 2

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
UNIT HYROGRAPHS
WHITEOAK CREEK
NEAR
GEORGETOWN, OHIO

SUBMITTED BY
DISTRICT ENGINEER, HUNT. DISTRICT

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DEPARTMENT OF THE ARMY — UNIT HYDROGRAPH BASIC DATA SHEET — CORPS OF ENGINEERS (SHEET 2 OF 2)

(7) STREAM AND STATION: WHITE OAK CREEK NEAR GEORGETOWN, OHIO LAT. 38°50'42" LONG. 83°55'16"

(8) DATE OF STORM: 8-9 Feb. 1950 (9) OFFICE: Huntington District

(10) DRAINAGE AREA: 222. SQ.MI. (11) L: 40. MI. (12) L_{ca}: 26.1 MI. (13) $(LL_{ca})^{0.3}$: 8.05

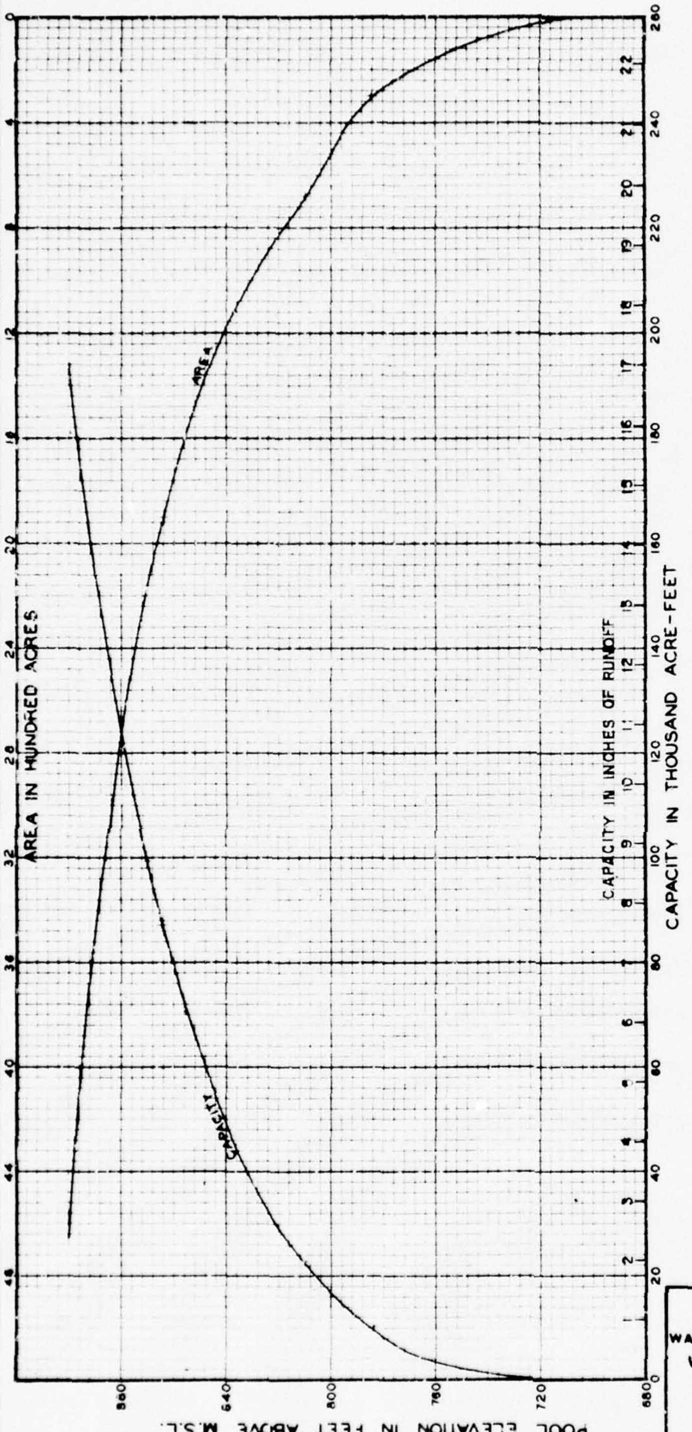
(14) AVERAGE RAINFALL: 1.74 IN. (15) t_R: 6. HRS. (16) DIRECT RUNOFF: 1.61 IN.

(17) Q_{pR}: 7,800. CFS. (18) q_{pR}: 35.3 CFS/SQ.MI. (19) Q_p: 8,220. CFS. (20) t_{pR}: 15.8 HRS.

(21) t_p: 15. HRS. (22) t_v: 16.5 HRS. (23) C_{tR}: 1.87 (24) C_p640: 557. W_{50}: 12.5 HRS. W_{75}: 9.0 HRS.

TIME Feb. 1950 (25)	OBSERVED DISCHARGE (~~1000~~ CFS) (26)	ESTIMATED BASE FLOW (~~1000~~ CFS) (27)	DIRECT RUNOFF (~~1000~~ CFS) (28)	OBSERVED 6 HR UNIT HYDROGRAPH (~~1000~~ CFS) (29)	ADJUSTED 6 HR UNIT HYDROGRAPH (~~1000~~ CFS) (30)	REPRODUCED STORM HYDROGRAPH (~~1000~~ CFS) (31)	(32)	(33)
8-6-P	165	165	0	0	0	150		
12-M	1,030	180	850	1,050	1,050	1,155		
9-6-A	6,770	175	6,595	5,150	5,150	5,580		
12-N	11,180	180	11,000	7,780	7,780	10,240		
6-P	9,830	185	9,645	4,715	4,715	9,535		
12-M	4,910	190	4,720	1,950	1,950	5,525		
10-6-A	1,360	195	1,165	700	700	2,370		
12-N	850	200	650	370	370	1,060		
6-P	635	205	430	250	250	660		
12-M	500	210	290	160	160	500		
11-6-A	410	215	195	120	120	410		
12-N	345	225	120	75	75	345		
6-P	315	235	80	45	45	315		
12-M	285	245	40	25	25	285		
12-6-A	255	255	0	0	0	255		

DATE COMPUTED BY



NOTE: CONTROLLED DRAINAGE AREA = 214 SQUARE MILES
ONE INCH RUNOFF = 11,400 ACRE-FEET

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK RESERVOIR PROJECT

AREA-CAPACITY CURVES

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON W. VA. JAN. 1968

each use and develop a plan of low flow regulation to satisfy each need. Successive trials of detailed sequential routings were run through the proposed reservoir using 43 years of historical stream flow records. The adopted plan of low flow regulation and the corresponding required storages proved sufficient to satisfy demands for the year 2075 for water supply, minimum release, recreation and water quality control. The minimum release would be provided 100 percent of the time and, based on priority of use, is combined with water supply for the purpose of allocation of storage. This release would provide for a portion of the water quality control needs and would provide a sustained flow for downstream fishery purposes and other aesthetic and riparian considerations. The combined storage allocated to water supply and minimum release was suballocated in proportion to the flows provided for each purpose. Required storage increments and priority of allocation for each water demand for the year 2075 are as follows:

Minimum release	2,450	acre-feet
Water supply	12,450	acre-feet
Subtotal, year around storage	14,900	acre-feet
Water quality control	3,700	acre-feet
Recreation	6,357	acre-feet
Total combined purposes	24,957	acre-feet

The adopted low flow rules of operation are shown on Exhibit 14-15. This adopted schedule should be considered only as a guide in the design stage of development since future refined rules are usually necessary, based on a more detailed study and on actual operation experience gained at similar existing projects.

Effects of Reservoir Regulation. The proposed plan of flood control regulation for Whiteoak Reservoir was tested by application to (1) major floods of record in Whiteoak Creek Basin (2) twelve representative Ohio River floods, and (3) the standard project flood for the reservoir. Reservoir reductions were determined and routed to selected downstream Ohio River damage centers to determine benefits attributed to Whiteoak Reservoir. The effective peak reductions at Cincinnati, Ohio, due to operation of Whiteoak Reservoir are presented in Table 14-14. Operational hydrographs at the dam site for the flood of January 1937 and the Standard Project Flood are shown on Exhibits 14-8 and 14-9, respectively.

TABLE 14-14

EFFECTIVE REDUCTIONS AT CINCINNATI, OHIO

Flood	Reductions attributed to Whiteoak Reservoir	
	Discharge - c.f.s.	Stage-feet
January 1927	500	.04
March 1933	7400	.56
March 1936	200	.01
January 1937	200	.01
February 1939	200	.01
April 1940	300	.02
January 1943	100	.01
March 1945	4200	.26
April 1948	300	.02
January 1950	0	.00
January 1952	100	.01
March 1955	200	.01

Based on 43 years of stream flow records, storage allocated for water supply (12,450 acre-feet) and minimum releases (2,450 acre-feet) will be sufficient to satisfy demands 100 percent of the time. Storage allocated for water quality control (3,700 acre-feet) will be sufficient to satisfy year 2075 demands during drought conditions having a recurrence interval of ten years. During drought conditions having a greater recurrence interval than ten years, some amount less than the desired water quality control demand would be provided in accordance with a regulation schedule.

Reservoir regulation for water supply, minimum releases and water quality control would result in drawdown of the seasonal pool from elevation 826.0. Extreme drawdown of the seasonal pool would tend to affect recreation development and usage during the prime-demand recreation months of June, July, and August. Drawdown-frequency curves were computed for each recreation month based on water demands for the years 2020 and 2075. At elevation 826, the pool surface area covers 931 acres. A drawdown of two feet decreases the surface area to 900 acres, five feet to 854 acres, ten feet to 774 acres and 15 feet to 694 acres. Table 14-15 presents frequency of drawdown values expected to occur for Whiteoak Reservoir during the months of June, July and August. The seasonal pool will not be drawn down until the 15th of November, except for water quality releases. This will have minimal effect on the goosery and occurs after the primer recreation season is over. The drawdown will have little adverse effect on the goosery or recreation until the year 2020.

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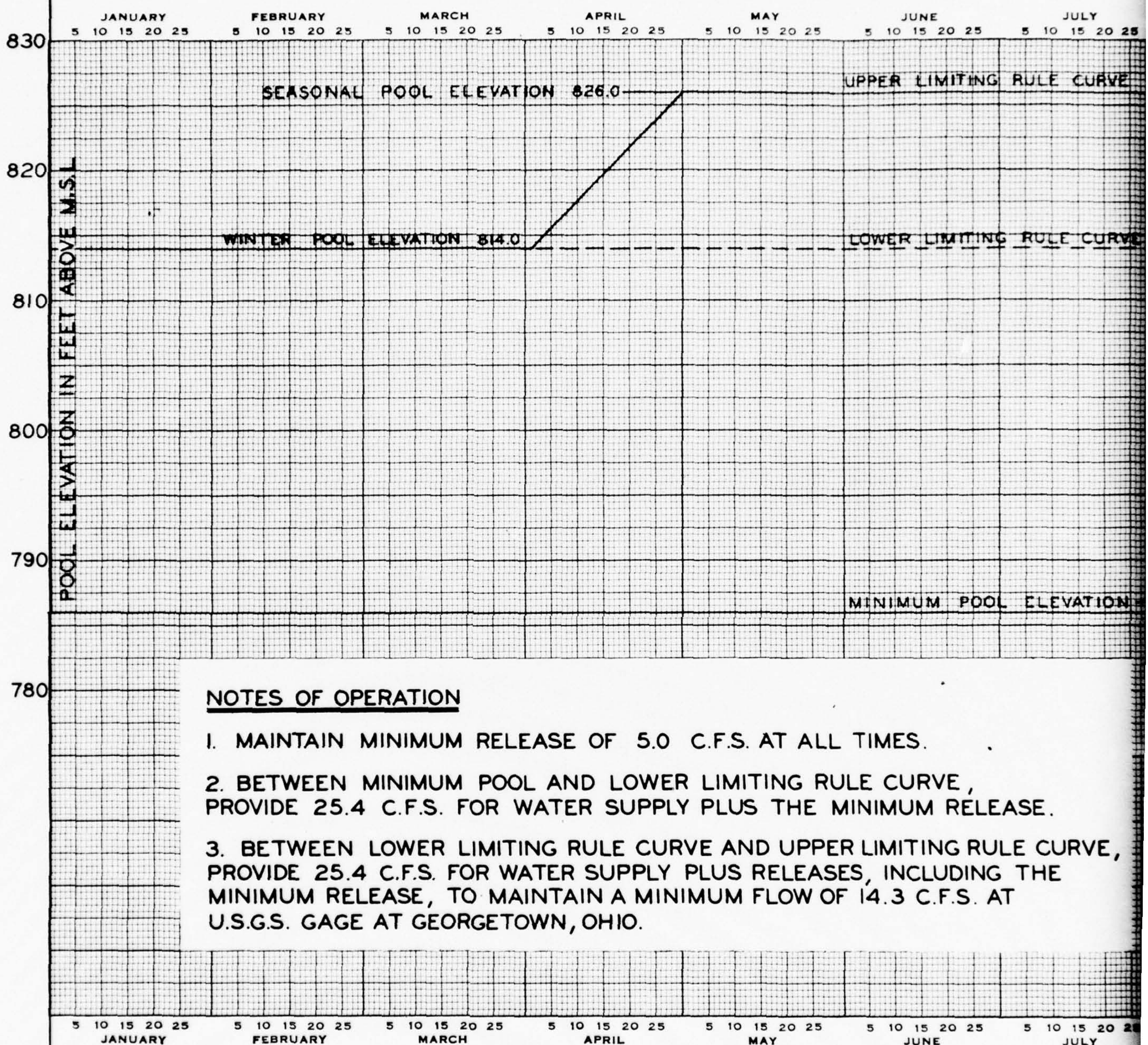


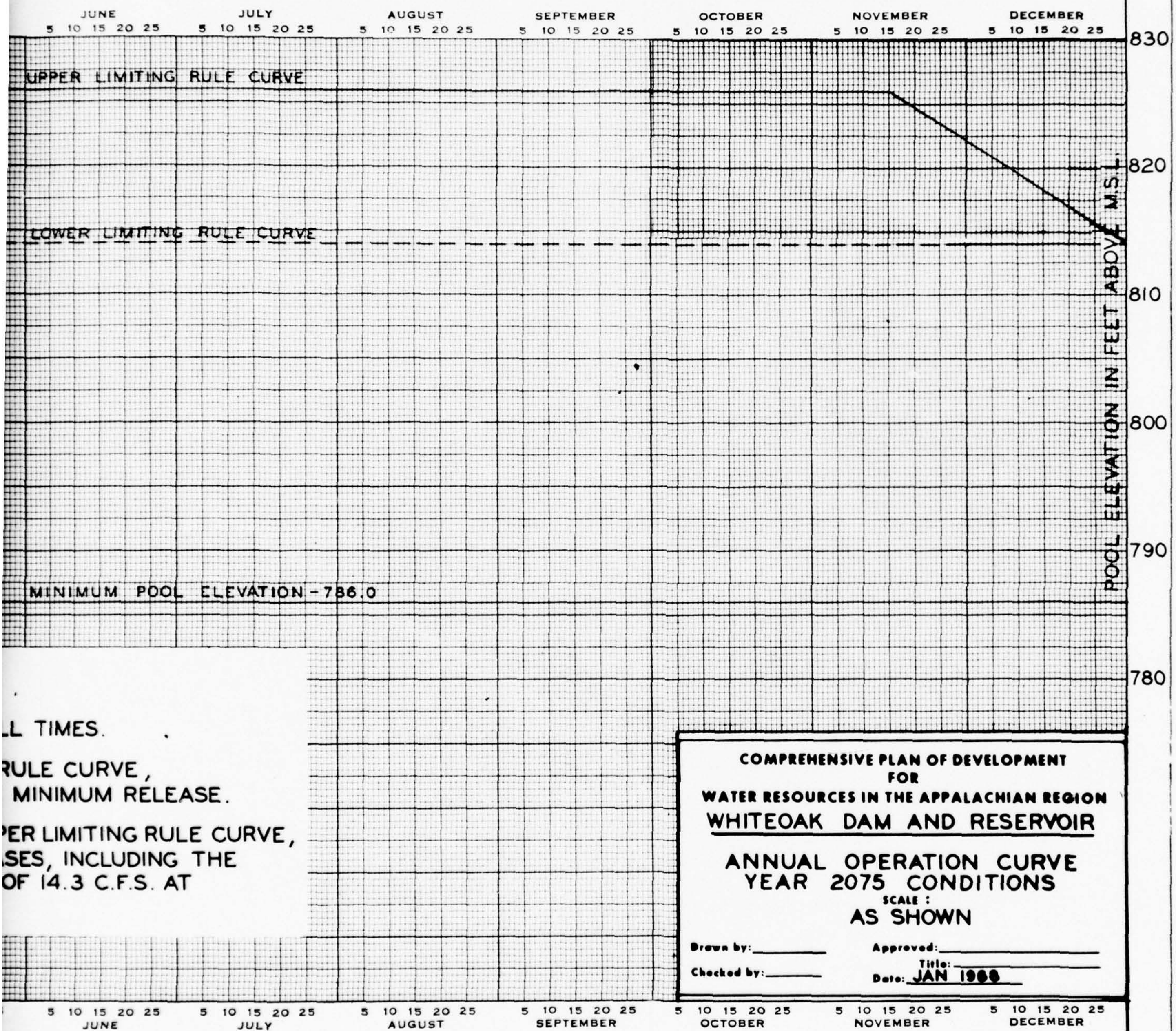
NOTES OF OPERATION

1. MAINTAIN MINIMUM RELEASE OF 5.0 C.F.S. AT ALL TIMES.

2. BETWEEN MINIMUM POOL AND LOWER LIMITING RULE CURVE, PROVIDE 25.4 C.F.S. FOR WATER SUPPLY PLUS THE MINIMUM RELEASE.

3. BETWEEN LOWER LIMITING RULE CURVE AND UPPER LIMITING RULE CURVE, PROVIDE 25.4 C.F.S. FOR WATER SUPPLY PLUS RELEASES, INCLUDING THE MINIMUM RELEASE, TO MAINTAIN A MINIMUM FLOW OF 14.3 C.F.S. AT U.S.G.S. GAGE AT GEORGETOWN, OHIO.

DEPARTMENT OF THE ARMY



LL TIMES.

RULE CURVE,
MINIMUM RELEASE.

PER LIMITING RULE CURVE,
SES, INCLUDING THE
OF 14.3 C.F.S. AT

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

ANNUAL OPERATION CURVE
YEAR 2075 CONDITIONS

SCALE :
AS SHOWN

Drawn by: ________ Approved: ________
Title: ________
Checked by: ________ Date: JAN 1968

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TABLE 14-15

WHITEOAK RESERVOIR PROJECT
FREQUENCY OF DRAWDOWN
AT END OF MONTH

WATER DEMANDS FOR YEAR 2020

Exceedence interval	Reservoir drawdown in feet for month of:		
In Years	June	July	August
1	0	0	0
2	.1	.2	.2
5	.6	1.0	1.6
10	2.0	2.6	3.7
20	4.4	4.9	6.3

WATER DEMANDS FOR YEAR 2075

Exceedence interval	Reservoir drawdown in feet for month of:		
In Years	June	July	August
1	0	0	0
2	.1	.2	1.4
5	2.6	3.5	5.3
10	5.4	6.8	9.0
20	8.6	10.5	13.0

Note: Computations were based on mean monthly flows

Hydrologic Basis for Real Estate Acquisition. Proposed criteria for acquisition of flowage rights in the reservoir area will be based on a guide taking line at elevation 865 (five feet above flood-control pool) or a line 300 feet horizontally from the top of the flood-control contour, whichever is greater. This criteria would conform with current real estate acquisition policy as outlined in EM 405-2-150. Since there are no major developments upstream from the dam site, backwater studies are not considered necessary to establish real estate taking line.

Hydraulic Design of Reservoir. The hydraulic design studies for the project included the determination of sizes of spillway and outlet works and elevations for the proposed multiple purpose reservoir. The hydraulic investigations conform to the usual procedures for structures of this type and were supplemented by data contained in Engineering Manuals, Hydraulic Design Criteria, and results of model and prototype studies for similar structures.

Project Design. Various types and sizes of spillways and outlet works were investigated before selection of the final design. The tunnel size was based on diversion requirements during construction of the project. The outlet tunnel and control structures will be used to pass flows during construction of the dam and for the release of impounded water after completion of the project. In addition to the permanent inlet conduits discharging into the tunnel, it is proposed to install a temporary passage in the intake structure to provide sufficient waterway opening during diversion. After diversion, the opening will be plugged with concrete and all releases will then be controlled by the service gates or low-flow gate valve. Pertinent data relative to the hydraulic design of the spillway are given in Table 14-16 and data on the outlet works and stilling basin are presented in Table 14-17.

TABLE 14-16

SPILLWAY DATA AND TOP OF DAM

Spillway crest elevation, feet, m.s.l.	860
Type of spillway	Broad-crested
Length in feet	500
Maximum pool elevation, feet, m.s.l.	881
Head on crest in feet	21
Peak inflow of spillway design flood, c.f.s.	165,000
Peak outflow of spillway design flood, c.f.s.	149,900
Freeboard in feet	5
Top of dam elevation, feet, m.s.l.	886

TABLE 14-17

OUTLET WORKS AND STILLING BASIN DATA

Tunnel size, diameter in feet	14 (circular)
Regulating gates, number and size	2 - 5'8" x 10'-0"
Low flow sluice, inches	30
Maximum outlet capacity, c.f.s.	9,300*
Stilling basin design discharge, c.f.s.	8,000
Width of stilling basin, feet	46
Length of curved apron, feet	95
Length of horizontal basin, feet	75
Invert elevation of stilling basin, feet, m.s.l.	673
Top of training wall, feet, m.s.l.	703

*After completion of project with pool at spillway level

10. GEOLOGIC

Regional Geology. The Whiteoak Creek Basin is located on the glaciated uplands of the Lexington Peneplain and the area is within the boundaries of glacial drift deposited by the Illinoian ice sheet. The drainage from the Lexington plain section in Ohio is to the south toward the Ohio River along parallel valleys of post glacial origin. The tributaries are deeply incised into bedrock with thin accumulations of alluvium covering the valley bottoms. Glacial deposits consisting mostly of till cover the flat upland plains of the area. The glacial deposits are usually thin except where preglacial valleys have been filled. Occasional deposits of residual clay have been found between the till and bedrock and a few wells have penetrated a "black mucky clay," considered to be preglacial soil, a few feet above bedrock. Sections of the till sheet, exposed in numerous road cuts, are normally gray but become brown or red-brown near the surface as a result of leaching and weathering. The gravel in the till is decomposed except for the most resistant pebbles. No deposits of sand and gravel were evident in the basin.

The rock in the Whiteoak Creek Basin was deposited during late Ordovician times on a fairly stable shallow marine shelf. The bedrock in descending geologic order consists of shales and thin bedded limestones of the Richmond, Maysville and Eden groups of the Cincinnatian series. These groups are generally differentiated on both a lithologic and faunal basis.

Structurally, the Whiteoak Creek Basin lies on the east flank of the Cincinnati Arch, a regional feature of great magnitude. The arch is a broad uplifted structure which courses western Ohio, through parts of Kentucky and into Tennessee. The rock strata in the Whiteoak Basin dip at low angles toward the east, interrupted only by minor anticlines and synclines. The Cincinnatian series are also known for their many minor sedimentary structures, including cross-bedding, sole markings, ripple marks, channels, conglomerates and penecontemporaneous slides of fairly wide magnitude.

Site and Reservoir Geology. The Whiteoak Dam and Reservoir Project would be located in Brown County, Ohio, less than one mile upstream from Georgetown, Ohio, approximately 2,000 feet north of the bridge on Ohio State Route 125 which crosses Whiteoak Creek. The elevation of Whiteoak Creek is about 700 feet above mean sea level at the site with the surrounding plains attaining an elevation of 250 to 300 feet higher.

Whiteoak Creek flows throughout most of its length over the Richmond and Maysville rocks. The Maysville group is present at the dam site and is the foundation rock for the pertinent structures. The Maysville group consists of alternating beds of shale and limestone

and for the group as a whole the shale predominates over the limestone in bulk. The limestones are bluish gray to buff in color and are well crystallized. The layers range from one inch to one foot in thickness but measure usually between two and six inches. The shale layers are blue-gray in color and calcareous in composition. Both shale and limestone are very fossiliferous. The total thickness of this group is approximately 175 feet.

The major joints at the dam site strike North 20° East and North 80° West. The joints are essentially vertical and spaced two feet to six feet apart in the thicker limestone strata. In the thin limestone strata, the joint spacing is much closer. The joints are moderately open on outcrops but close up with depth. In the streambed and on outcrop where the rock is exposed to weathering, the rock readily breaks along the joint planes into blocks of varying size. The average dip of the rocks in the area of the site is approximately 2° toward the east with minor north and south trending undulations. Because of the predominance of shale in the Maysville group and the thin bedded characteristics of the limestones, it is unlikely that solution activity is present and none was evident in the reservoir area.

The shale content of the Maysville and Richmond groups also precludes their development in the reservoir area for use as quality construction materials. There is, however, limited development of these materials for agricultural lime and crushed stone for county and township road construction. The bedrock in the reservoir area is not productive of oil, gas and other minerals of value.

Subsurface investigations. Subsurface investigations included NX-size rock core drilling and auger sampling of overburden. A geology and soils legend is shown on Exhibit 14-16. Six NX-size core borings were drilled during investigation of the dam site, spillway and tunnel at locations shown on Exhibit 14-17. The borings were located on the basis of the design layout proposed at that time. Subsequent reformulation of the project resulted in a change in the locations of the spillway and outlet tunnel. A detailed geologic classification was made and graphic logs of the borings are shown on Exhibit 14-18. The holes were not pressure tested.

Eleven auger borings at locations shown on Exhibit 14-19 were drilled during investigations for impervious borrow material. Samples were obtained at maximum intervals of five feet or at every change in materials from borings A62-1 through A62-6 and A62-11. Composite bag samples were taken from borings A62-1 through A62-11. In addition, jar samples of the overburden materials were taken from borings C62-3, C62-4, C62-5 and C62-6. All overburden samples from the above borings were shipped to the Ohio River Division Laboratories for routine identification and classification tests. Test results are shown on graphic logs Exhibit 14-18 and gradation curves Exhibit 14-20.

UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions (1)	(2)		Group Symbols (3)	Symbol: Hatching (4)	Symbol: Color (5)	Typical Names (6)	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights) (7)		
Coarse-grained Soils. More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels. More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW		Red	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		
			GP		Red	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Gravels with Fines (Appreciable amount of fines)	GM		Yellow	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			GC		Yellow	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
	Sands. More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW		Red	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.		
			SP		Red	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Sands with Fines (Appreciable amount of fines)	SM		Yellow	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			SC		Yellow	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
							Identification Procedures on Fraction Smaller than No. 40 Sieve Size		
							Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)
Fine-grained Soils. More than half of material is smaller than No. 200 sieve size.	Silts and Clays	Liquid limit less than 50	ML		Green	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None
			CL		Green	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium
			OL		Green	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight
	Silts and Clays	Liquid limit greater than 50	MH		Blue	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium
			CH		Blue	Inorganic clays of high plasticity, fat clays.	High to very high	None	High
			OH		Blue	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium
Highly Organic Soils			Pt		Orange	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		

Information Required for Describing Soils (8)

Coarse-grained soils:

For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.

Give typical name; indicate approximate percentages of sand and gravel, max. size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.

Example:
Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).

Fine-grained soils:

Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses.

For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.

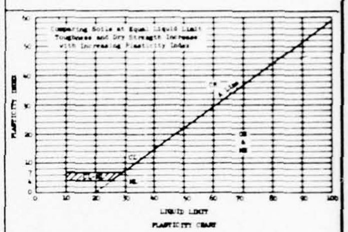
Example:
Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).

Laboratory Classification Criteria (9)

Use grain-size curve in identifying the fractions as given under field identification.

Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows:
Less than 5% GW, GP, SW, SP.
More than 12% GM, GC, SM, SC.
5% to 12% Borderline cases requiring use of dual symbols.

$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits below "A" line with PI greater than 7	
$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
Not meeting all gradation requirements for SW	
Atterberg limits below "A" line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits above "A" line with PI greater than 7	



PLASTICITY CHART

For laboratory classification of fine-grained soils

(1) **Boundary classifications**: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

ABBREVIATIONS

a.	angle	disc.	discontinuous	lea.	leached	s.	soft
alt.	alternate(ly)(ing)	diss.	disseminated	len	lense(s)	sa.	sandy
amt	amount	dk	dark	lg	large	sat	saturated
ang	angular	dn	dense	lt.	light	scat	scattered
approx.	approximate(ly)	dmp	damp			se.	seams
ar	argillaceous			m.	moderate, medium	sev.	severely
aren.	arenaceous	ext.	extremely	ma.	many	sevr	several
asp.	asphaltic			mas	massive(ly)	sh	shaly
		f.	fine	mat	material	sil.	siliceous
b.	bone	fer.	ferruginous	mic	micaceous	si.	silty
ba	banded(ing)	fis	fissile	min.	mineralized	sl.	slight(ly)
bd	bedded(ing)	fil.	filled(ing)	mos.	mostly	slk.	slickensided
bdr	bedrock	fos.	fossiliferous	mot	mottled	sm	small
bf	buff	frac.	fracture(d)	mst	moist	so.	some
bk	black	frags.	fragment(s)(al)	mtx	matrix	sol	solution
bky	blocky	fri.	friable			sta	stain(ed)
bkn	broken	f.w.	free water	n.	near	stf	stiff
bl	blue			nod	nodule(s)	stks	streak(s)
bou	boulder(s)	g.	grain(ed)	num.	numerous	str.	stringer(s)
brc	brecciated	gen	generally			sty	stylolite(ic)
br	brown	gn	green	o.	open		
		gr	grey	occ.	occasional(ly)	t.	thin
c.	coarse	gra.	gravelly	occu.	occurring	tho.	throughout
ca	calcareous	grad.	grading(ed)	org.	organic	tk	thick
carb.	carbonaceous	G.W.	ground water			tr.	trace
cav	cavern, cavity			pa.	parting(s)		
cbl	cobble(s)	h.	hard	part.	particle(s)	v.	variably
ch	chalk	ha	high angle	pl.	plastic	va.	variegated
cl	clay	hi	highly(ier)	peb.	pebble(s)	ve.	very
cla	clayey	hor	horizontal(ly)	pk	pink	veg	vegetation
[illegible]	coated(ing)			pkt	pocket(s)	ver.	vertical(ly)
[illegible]	compact	inc	inclusions	pit	pit(ted)	vu	vuggy
[illegible]	concretion	incr.	increasing(ly)	pl	plane(s)		
[illegible]	conglomeratic	inter.	interlaminated	po	porous	w	water
[illegible]	contains	intbd	interbedded	pt	part(ly)	w	with
[illegible]	crushed	irr.	irregular	pyr.	pyrite(ic)	w.c.	water content
[illegible]	crumbly					wd	weathered
[illegible]	crystalline	jt.	joint(ed)	q.	quartzitic	wh.	white
[illegible]	cemented						
		l.	little	r.	red	x-bd.	cross bedded(ing)
d.	dirty	la	low angle	ro.	rock(s)		
dia.	diameter	lam.	lamination(s)(ed)	rot.	rotten(ed)	y.	yellow
dip	dipping	lay	layer(s)	rou	round(ed)		
dis.	disintegrated	lr	[illegible]	rt.	root(s)(let)	zo.	zone

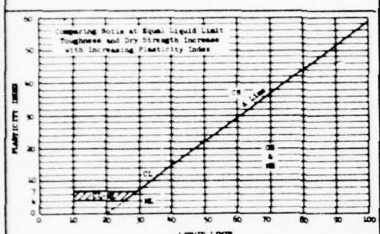
LEGEND FOR GRAPHIC LOGS OF

Laboratory Classification Criteria

$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 ; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits below "A" line with PI greater than 7	
$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 ; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
Not meeting all gradation requirements for SW	
Atterberg limits below "A" line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits above "A" line with PI greater than 7	

Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows:
Less than 5% GW, GP, SW, SP;
More than 12% GM, GC, SM, SC;
5% to 12% Borderline cases requiring use of dual symbols.

Use grain-size curve in identifying the fractions as given under field identification.



PLASTICITY CHART

For laboratory classification of fine-grained soils

...mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

...classification purposes.
...tests.

...sistency near plastic limit)

...particles larger than the No. 40 sieve size, a specimen of soil about one-half ... in size, is molded to the consistency of putty. If too dry, water must be added ...sticky, the specimen should be spread out in a thin layer and allowed to lose some ... evaporation. Then the specimen is rolled out by hand on a smooth surface or ... palms into a thread about one-eighth inch in diameter. The thread is then ... rerolled repeatedly. During this manipulation the moisture content is gradually ... the specimen stiffens, finally loses its plasticity, and crumbles when the plas... is reached.
...thread crumbles, the pieces should be lumped together and a slight kneading action ... until the lump crumbles.
... the thread near the plastic limit and the stiffer the lump when it finally crum... more potent is the colloidal clay fraction in the soil. Weakness of the thread ...astic limit and quick loss of coherence of the lump below the plastic limit indi... inorganic clay of low plasticity, or materials such as kaolin-type clays and ... which occur below the A-line.
...ic clays have a very weak and spongy feel at the plastic limit.

ROCK

SYMBOLS

SYMBOL	NAME	ABBREVIATION
	SANDSTONE	SS.
	CONGLOMERATE	CONG.
	SHALE	SH.
	SILTSTONE	SLS.
	CLAYSTONE	CLS.
	LIMESTONE	LS.
	COAL	C.
	INDURATED CLAY	ICL.
	DOLOMITE	DO.

HARDNESS

Very soft or plastic	- Can be indented easily with thumb.
Soft	- Can be scratched with fingernail.
Moderately hard	- Can be scratched easily with knife; cannot be scratched with fingernail.
Hard	- Difficult to scratch with knife.
Very hard	- Cannot be scratched with knife.

BEDDING

FISSILE	- laminae < 2mm (approx. 0.08")
SHALY	- laminae 2-10mm (approx. 0.08"-0.4")
FLAGGY	- layers 10-100mm (approx. 0.4"-4")
THIN BEDDED	- strata 4"-12"
MASSIVE	- strata > 12"

SOILS

SYMBOLS

SYMBOL	NAME	ABBREVIATION
	UNCLASSIFIED	UN.
	TOPSOIL	T.
	CLAY	CL.
	SILT	SL.
	SAND	SA.
	GRAVEL	GR.
	COBBLES	CBL.
	BOULDERS	BDU.
	SAND, GRAVEL & OCCASIONAL BOULDERS	

STANDARD PENETRATION TEST

Relative Density of Sands

No. of Blows (N)	Relative Density
< 4	Very loose
4-10	Loose
10-30	Medium dense
30-50	Dense
> 50	Very dense

Consistency of Clays

No. of Blows (N)	Consistency	Unconfined Compressive Strength tons/ft.²
< 2	Very soft	< 0.25
2-4	Soft	0.25-0.50
4-8	Medium stiff	0.50-1.00
8-15	Stiff	1.00-2.00
15-30	Very stiff	2.00-4.00
> 30	Hard	> 4.00

From "Soil Mechanics in Engineering Practice" by Terzaghi & Peck

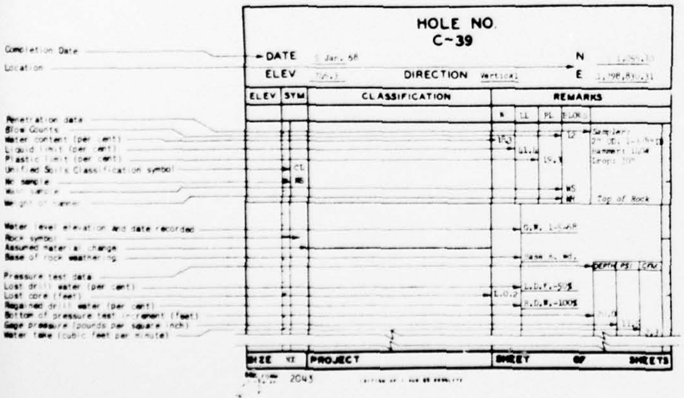
NUMBER AND TYPE OF EXPLORATIONS

HOLE NO	CODE DESIGNATION
C-39	Core hole in bedrock
D-20	Disturbed sample boring
UD-15	Undisturbed sample boring
A-2	Auger hole, hand or power auger, 2" to 24" diameter
	Core hole in bedrock, hydraulic pressure tested
	Indicates angle boring, shows direction
	Observation hole, ground water
TP-42	Test pit in overburden
T-7-135	Test trench in overburden (T-7), soils classified at stationing shown (135)

WEATHERING

SEVERE WEATHERING	- Loss of rock coherance, granular and or decomposed in place (saprolite). Characterized by poor drill recovery.	- AREA A	- Material can be excavated by hand tools.
MODERATE WEATHERING	- Rock may be oxidized but most physical characteristics remain. Material consists of closely jointed and partly decomposed rock and is characterized by gap spaced core losses.	- AREA B	- Occasional blocks may be removed by hand tools. Can be ripped with a D-8 dozer and is workable in wet weather.
SLIGHT WEATHERING	- Rock generally fresh, with a system of open planes of separation continuous within the area. Various degrees of weathering occur along joints and bedding. Moldable material, up to 1/4" in thickness, may be encountered along separation planes.	- AREA C	- Material is rippable only where separation planes are spaced one foot or less in all directions.
FRESH ROCK	- Intact rock with scattered and discontinuous planes of separation. Characterized by complete or near complete core recovery.	- AREA D	- Requires systematic drilling and blasting to excavate.

LEGEND FOR GRAPHIC LOGS OF BORINGS



COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM & RESERVOIR

GEOLOGY AND SOILS LEGEND

SCALE

Drawn by:________ Approved:________

Checked by:________ Title:________

Date:________

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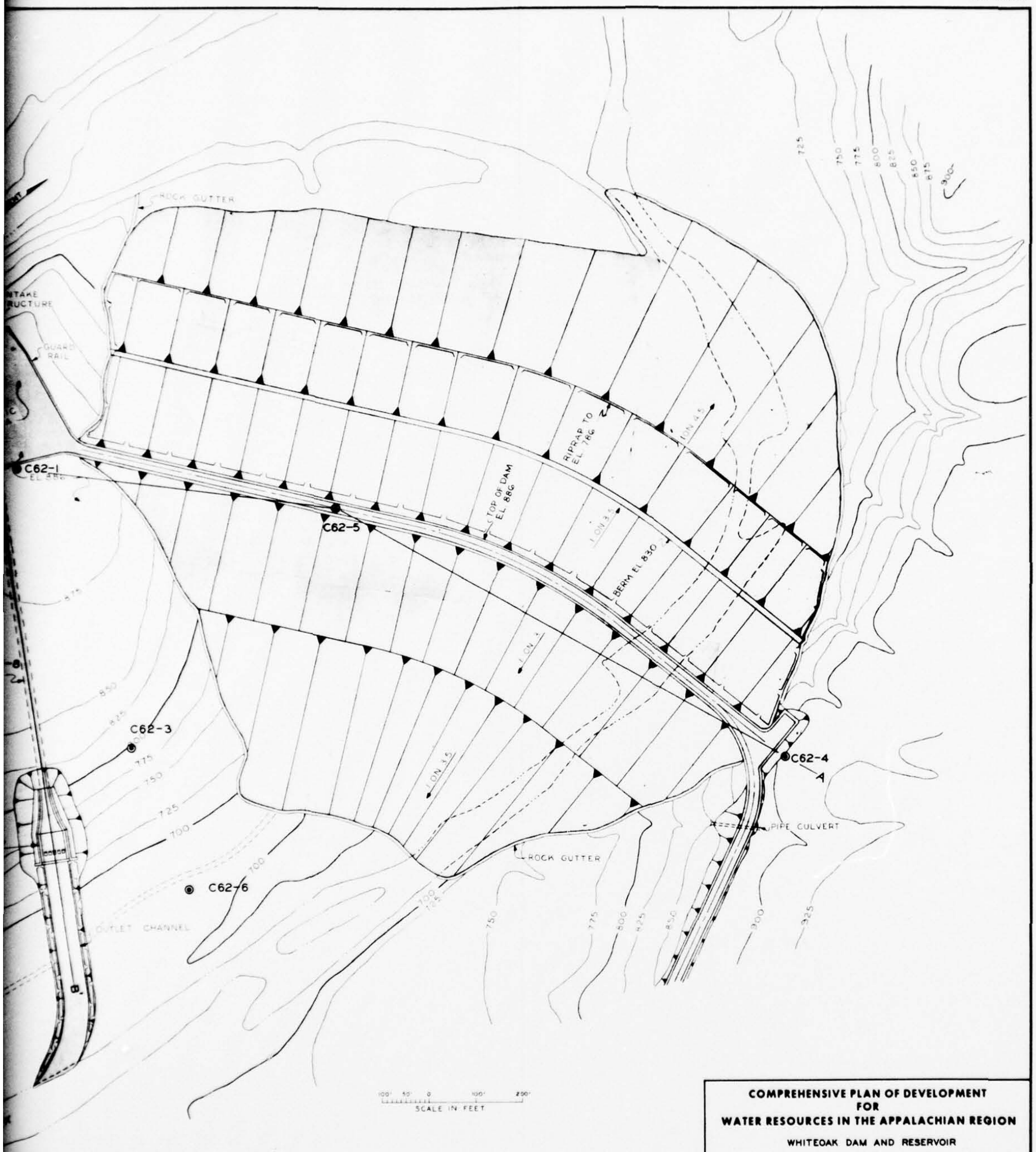
CORPS OF ENGINEERS



100' 50' 0 100' 200'
SCALE IN FEET

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

BORING LOCATION PLAN

SCALE:
AS SHOWN

Drawn by: RMK

Checked by: BDR-PMW   Date: JAN 1968

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HOLE NO. C62-1

DATE 31 Oct. 1962 — N For location of
ELEV 905.0 — DIRECTION Vertical — E hole see map

ELEV	SYM	CLASSIFICATION		REMARKS
905.0				
				Augered
				Classified by field personnel
	CL	SANDY CLAY, lt. br.		
886.8				Started coring at 886.8
		LIMESTONE frags. & till		LS. frag. to 0.2 max. size.
			L.0.6	
880.1			L.1.4	Top of Rock
			L.0.8	
		SHALE, cl., t.bd., s.-m.h.,gr., air slacking, inthd./40% lime-stone,h., gr.fos.	L.0.2	
			L.2.0	
		fer. sta. zo. from 875.5-874.8	L.2.0	
		fer. sta. wd. zo. from 856.5 to 854.9	L.0.2	
		o. fer. sta. hi. a. jt. # 851.5		
			L.0.2	

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 2 SHEETS

CONTD. C62-1

ELEV	SYM	CLASSIFICATION		REMARKS
855.0				
850.6			L.0.8	
		Limestone, h., gr., fos., intbd./ Shale, cl., m.h., & num. LS. nod., so. air slaking		
			L.0.2	
830.0			L.0.2	
		Bottom of Hole		

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 2 OF 2 SHEETS

HOLE NO. C62-2

DATE 14 Nov. 1962 — N For location of
ELEV 845.0 — DIRECTION Vertical — E hole see map

ELEV	SYM	CLASSIFICATION		REMARKS
845.0				
				Augured
	ML	CLAYEY SILT, gr./occ. BOU.		Classified by field personnel
840.0				Top of Rock
		Limestone, h.,gr.,fos.,inthd./40% Shale, cl., m.h., 0.3 fer. sta. wd. zo. # 839.7		G.W. 11/14/62
835.0				
		SHALE, cl., gr., m.h.,so. air slaking inthd/50% limestone h.,gr.fos		
		o. ha. jt. # 826.9		
805.0			L.0.4	
802.5		Shale, m.h., gr.		

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 2 SHEETS

HOLE NO. C62-3

DATE 21 Nov. 1962 — N For location of
ELEV 823.5 — DIRECTION Vertical — E hole see map

ELEV	SYM	CLASSIFICATION	W	LL	PL	REMARKS
823.5						
						Augured
	CL	LEAN CLAY (CL), br.				
818.0			13.6	42.6	19.5	Top of Rock
		Limestone, h., gr., fos./Shale,br., sev. wd. se.				L.D.W.
		0.3 fer. sta. wd. zo. # 811.3	L.1.8			
811.0		Wd., fer. sta. zo. # 810.7	L.0.5			
		Limestone, h., gr., fos.,inthd./40% Shale, cl., s.-m.h., gr., air slaked,				
		o. ver. jt. # 809.7				
		o. fer. sta,ha.jt. # 806.6 & 804.5				
		o.ha.jt,wd. & fer.sta. # 802.2				
		o. la.jt., fer. sta. # 797.2				
		o.fer. sta. ver. jt. # 796.3				
		o.ha.jt. # 787.6, 778.5, 777.9, 776.1, 773.6, 769.3 & 767.0				
		fil. ha. jt. # 761.2				
			L.0.5			
						G.W. 11/21/62

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 3 SHEETS

CONTD. C62-3

ELEV	SYM	CLASSIFICATION		REMARKS
773.5				
			L.0.2	
755.1				
		SHALE, cl.,m.h.,gr. inthd./50% Limestone h., gr.fos.		
		ha. jt. # 754.2		
		fer. sta. ha. jt. # 753.8 & 746.1		
		ha. jt. # 738.3, 735.5 & 735.4		
			L.0.1	
				G.W. 11/23/62
737.0				
				LS. lay. 0.3 max. size
		Shale, m.h., gr.,air slaked/occ.t. Limestone lay		
		ver. jt. # 725.2		
		ver. recem. frac. # 709.9		

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 2 OF 3 SHEETS

CONTD. C62-3

ELEV	SYM	CLASSIFICATION		REMARKS
723.5				
709.9				
		SHALE, cl.,m.h.,gr. inthd/50% Limestone h., gr., fos.		
		o. ha. jt. # 699.6		
		o. ha. jt. # 694.8		
693.5			L.0.4	
		Bottom of hole		

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 3 OF 3 SHEETS

2

HOLE NO.
C62-2

, 1962 — DIRECTION Vertical — N For location of / E hole see map

CLASSIFICATION	REMARKS
SILT, gr./occ. BOU.	Augured Classified by field personnel Top of Rock
Limestone, h.,gr.,fos.,intbd./40% Shale, cl., m.h., fer. sta. wd. zo. # 839.7	G.W. 11/14/62
SHALE, cl., gr., m.h., ... slaking intbd/30% limestone h.,gr.,fos o. ha. jt. # 826.9	L.O.4
Shale, m.h., gr.	

PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 2 SHEETS

CONTD.
C62-2

ELEV	SYM.	CLASSIFICATION	REMARKS
795.0			
		Limestone, h., gr., intbd./40% Shale, m.h., gr.	
770.0			L.I.1
		Bottom of Hole	

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 2 OF 2 SHEETS

CONTD.
C62-3

CLASSIFICATION	REMARKS
SHALE, cl.,m.h.,gr. intbd/30% limestone h., gr., fos. o. ha. jt. # 699.6 o. ha. jt. # 694.8	L.O.4
Bottom of Hole	

PROJECT WHITEOAK CREEK RESERVOIR — SHEET 3 OF 3 SHEETS

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GRAPHIC LOGS OF BORINGS

SCALE
AS SHOWN

III-14-69 SHEET 1 OF 3 EXHIBIT 14-18

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HOLE NO. C62-4

DATE 29 Nov. 1962 — ELEV 907.3 — DIRECTION Vertical — N For location of / E hole see map

ELEV	SYM.	CLASSIFICATION	w	REMARKS
907.3				
	CL	LEAN CLAY (CL), br.		Augured
901.6			16.2	Top of Rock
		Limestone, h.,gr.,fos./t.bd.wd. Shale, air slaked & Clay se.	L.2.9	
			L.0.9	
882.1			L.0.8	
			L.0.1	
		SHALE, m.h.gr.wd. intbd/50% limestone, h., gr.		
		o. fer. sta. ver. jt. @884.4 o.ho. jt. @ 883.0		
				G.W. 11/27/62

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 2 SHEETS

CONTD. C62-4

ELEV	SYM.	CLASSIFICATION	REMARKS
857.3			
857.0			
		Limestone, h., gr., fos., intbd./ 40% Shale, cl., m.h., gr., air slaked.	
			Bottom of Hole

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 2 OF 2 SHEETS

HOLE NO. C62-5

DATE 30 Nov. 1962 — ELEV 741.0 — DIRECTION Vertical — N For location of / E hole see map

ELEV	SYM	CLASSIFICATION	w	LL	PL	REMARKS
741.0						
739.0	CL	SANDY SILTY CLAY (CL), dk. br.	20.6			Augured G.W. 11/30/62
737.5	CL	SANDY CLAY (CL), br.	16.1			
737.0	SM	SILTY SAND (SM), br.	16.1	N.P		
735.0	CL	SANDY SILTY CLAY (CL), br.	17.5			
			18.6			
733.0	CL	SANDY CLAY (CL), dk. br.	17.7			
732.5	CL	LEAN CLAY (CL), gr.	19.9			Top of Rock
729.5		Limestone, h.,gr./Shale,cl.,gr.,s., se.	L.0.6			
		Shale, cl., s.-m.h., gr., air slaked/0.2 wd. se. from 726.9 to 726.7	L.0.5			
		0.7 Limestone, h., gr., from 722.9 to 722.2				
721.5			L.0.1			
		Bottom of Hole				

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

HOLE NO. A62-1

DATE 11 Dec. 1962 — ELEV ____ — DIRECTION Vertical — N For location of / E hole see map

DEPTH	SYM.	CLASSIFICATION	W	LL	PL	REMARKS
0.0						
0.5		Top Soil				Augured
	CL	LEAN CLAY (CL), br./tr. of SAND	20.6	43.5	20.5	
			20.6			
15.0			19.6			
	CL	SANDY CLAY (CL), br.				
20.0			15.8			
		Bottom of Hole				

SIZE — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

HOLE NO. A62-2

DATE 11 Dec. 1962 — ELEV ____ — DIRECTION Vertical — N For location of / E hole see map

DEPTH	SYM	CLASSIFICATION	W	LL	PL	REMARKS
0.0						
0.5		Top Soil				Augured
		SANDY CLAY (CL), br.				
5.0			13.0	32.2	15.4	
		Bottom of Hole				

SIZE — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

HOLE NO. A62-3

DATE 11 Dec. 1962 — ELEV ____ — DIRECTION Vertical — N For location of / E hole see map

DEPTH	SYM	CLASSIFICATION	w	REMARKS
0.0				
0.5		Top Soil		Augured
	CL	LEAN CLAY (CL), gr./few ro. frags.	17.6	
7.0			19.1	
		Bottom of Hole		

SIZE — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

2

HOLE NO. C62-5

DIRECTION Vertical — N For location of / E hole see map

CLASSIFICATION	W	LL	PL	REMARKS
(CL), dk. br.	20.6			Augured G.W. 11/30/62
br.	16.1			
br.	16.1	N-P		
(CL), br.	17.5			
	18.6			
dk. br.	27.7			
gr.	19.9			Top of Rock
/Shale, cl., gr., s.,	1.0.6			
h., gr., air ... from 726.9 to	1.0.5			
., gr., from				
	.0.1			
Hole				

CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

HOLE NO. C62-6

DATE 3 Dec. 1962 — N For location of
ELEV 700.0 — DIRECTION Vertical — E hole see map

ELEV	SYM	CLASSIFICATION	W	LL	PL	REMARKS
700.0						
698.0	SM	SILTY SAND(SM), br./rt. & ro. frags.	21.4			Augured
696.0	GM	SILTY SANDY GRAVEL (GM), gr.		N-P		
[illegible].0	NS	No Sample				Top of Rock
		Shale, cl., s.-m.h., gr., wd., air slaked, intbd./50% Limestone, h., gr., fos.	1.0.5			G.W. 12/3/62
685.0			1.0.1			
		Bottom of Hole				

SIZE NX — PROJECT WHITEOAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

HOLE NO. A62-3

DIRECTION Vertical — N For location of / E hole see map

CLASSIFICATION	W	REMARKS
		Augured
, gr./few ro. frags.	17.6	
	19.1	
of Hole		

OAK CREEK RESERVOIR — SHEET 1 OF 1 SHEETS

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GRAPHIC LOGS OF BORINGS

SCALE

Drawn by: ________

Checked by: ________ Date: ________

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HOLE NO. A62-4

DATE 19 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	w	REMARKS
0.0				
0.5		Top Soil		Augured
	CL	LEAN CLAY (CL), br. & gr./tr. of SAND		
3.0			19.4	
		Bottom of Hole		

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

HOLE NO. A62-5

DATE 14 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	w	LL	PL	REMARKS
0.0						
0.5		Top Soil				Augured
	CL	SANDY CLAY (CL), br. & gr.	22.6	51.8	19.8	
7.8			21.4			
		Bottom of Hole				

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

HOLE NO. A62-6

DATE 14 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	w	REMARKS
0.0				
0.6		Top Soil		
	CL	LEAN CLAY (CL), lt. br./tr. of SAND & ro. frags.		Augured
3.1			12.5	
		Bottom of Hole		

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

HOLE NO. A62-8

DATE 9 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	REMARKS
0.0			
0.5		Top Soil	Augured
	ML	CLAYEY SILT, reddish br.	Classified by Field Personnel
14.0			
		Bottom of Hole	

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

HOLE NO. A62-9

DATE 4 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	REMARKS
0.0			Augured
		SHALE frags., sa., lt. br.	Classified by Field Personnel
5.2			
		Bottom of Hole	

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

HOLE NO. A62-10

DATE 4 Dec. 1962 | ELEV | DIRECTION Vertical | N For location of | E hole see map

DEPTH	SYM	CLASSIFICATION	REMARKS
0.0			
		SHALY CLAY, lt. br.	Augured Classified by Field Personnel
2.2			
		Bottom of Hole	

SIZE | PROJECT WHITEOAK CREEK RESERVOIR | SHEET 1 OF 1 SHEETS

HOLE NO. A62-6

Dec. 1962 DIRECTION Vertical N For location of E hole see map

CLASSIFICATION	W	REMARKS
Top Soil		
CLAY (CL), lt. br./tr. of SAND ro. frags.	12.9	Augured
Bottom of Hole		

PROJECT WHITEOAK CREEK RESERVOIR SHEET 1 OF 1 SHEETS

HOLE NO. A62-7

DATE 4 Dec. 1962
ELEV
DIRECTION Vertical N For location of E hole see map

DEPTH	SYM	CLASSIFICATION	REMARKS
0.0			
0.3		Top Soil	Augured
	CL	SILTY CLAY, lt. br. (dry)	Classified by Field Personnel
20.2		Bottom of Hole	

SIZE PROJECT WHITEOAK CREEK RESERVOIR SHEET 1 OF 1 SHEETS

HOLE NO. A62-10

4 Dec. 1962 DIRECTION Vertical N For location of E hole see map

CLASSIFICATION	REMARKS
SHALY CLAY, lt. br.	Augured Classified by Field Personnel
Bottom of Hole	

PROJECT WHITEOAK CREEK RESERVOIR SHEET 1 OF 1 SHEETS

HOLE NO. A62-11

DATE 19 Dec. 1962
ELEV
DIRECTION Vertical N For location of E hole see map

DEPTH	SYM	CLASSIFICATION	W	LL	PL	REMARKS
0.0						
0.5		Top Soil				Augured
	CL	SANDY CLAY (CL), br.				
5.0			19.4	30.1	16.5	
	CL	SANDY CLAY (CL), br./sm. ro. frags.				G.W. 12-19-62
10.0						
		Bottom of Hole				

SIZE PROJECT WHITEOAK CREEK RESERVOIR SHEET 1 OF 1 SHEETS

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GRAPHIC LOGS OF BORINGS

SCALE

Drawn by: ____
Checked by: ____ Date: ____

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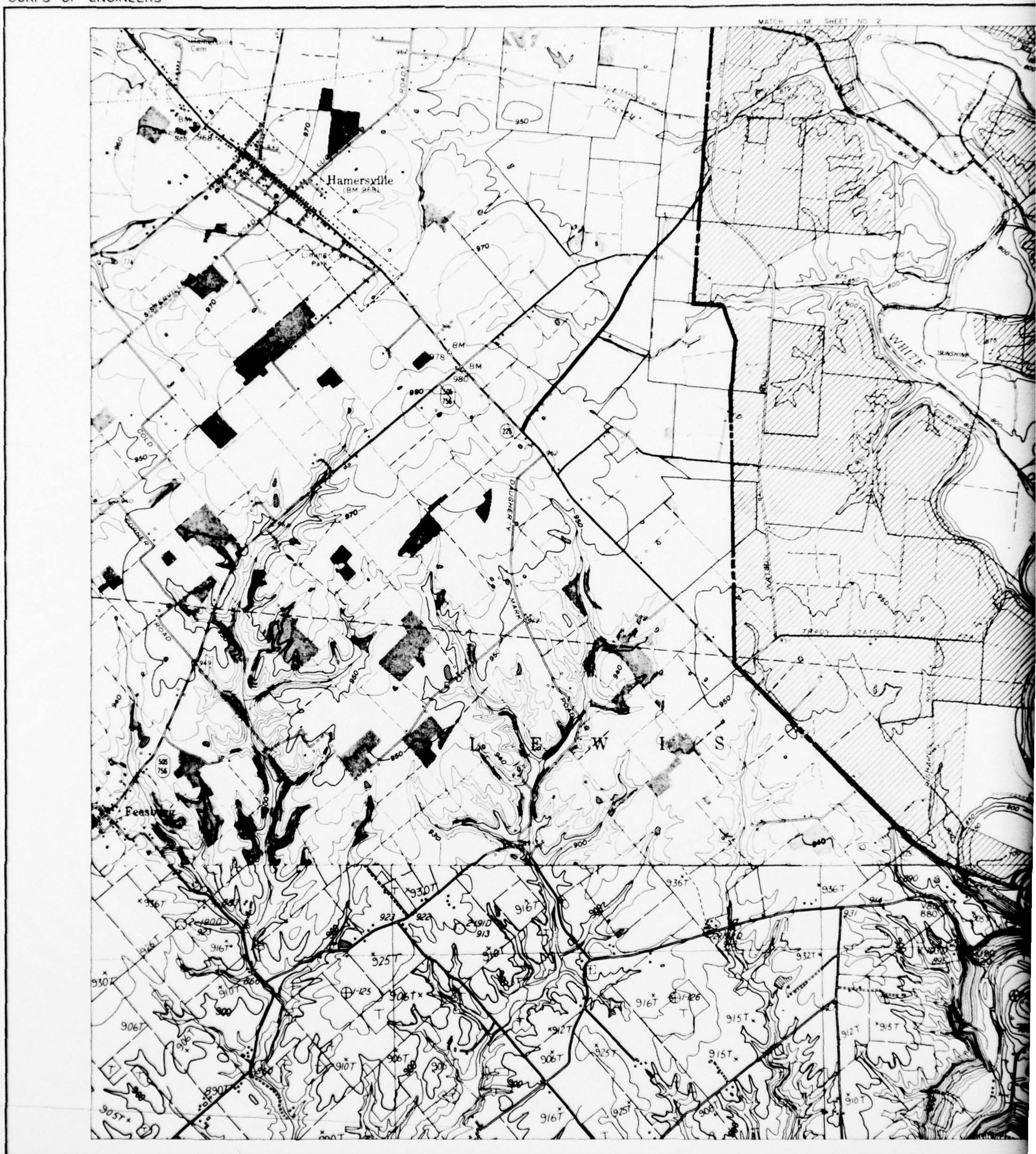
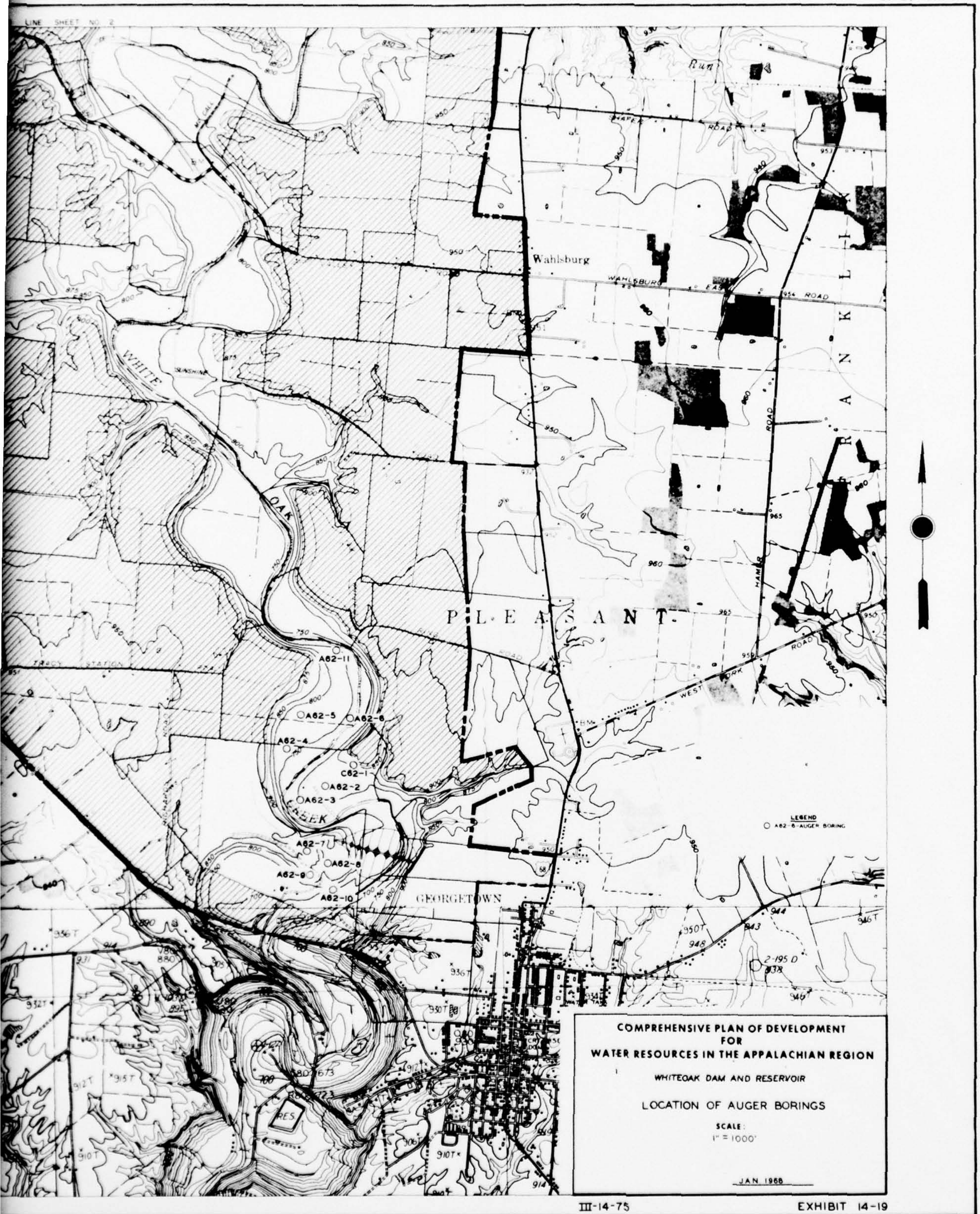
CORPS OF ENGINEERS



U. S. ARMY



COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

LOCATION OF AUGER BORINGS

SCALE: 1" = 1000'

JAN. 1966

EXHIBIT 14-19

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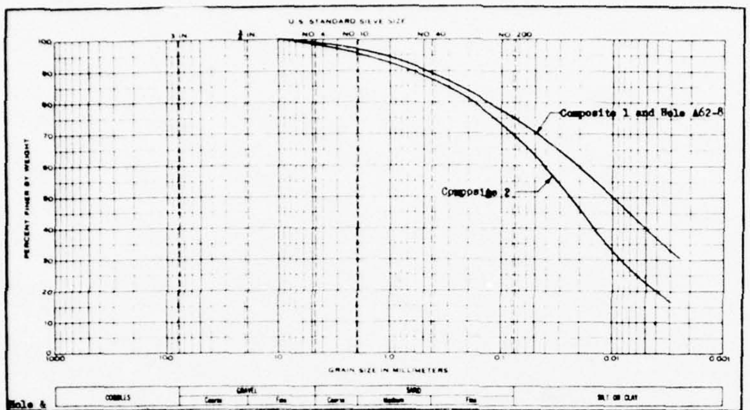


Hole & Sample No	Elev or Depth	Classification	Nat WC	LL	PL	PI	Composite
A62-1 thru 7, Bag 1 from each hole.		Sandy CLAY (CL)		35.3	19.0	16.3	1
A62-7, Bags 2 & 3		Sandy CLAY (CL)		29.5	15.9	13.6	2
A62-8, Bag 1		Sandy CLAY (CL)		35.7	19.7	16.0	

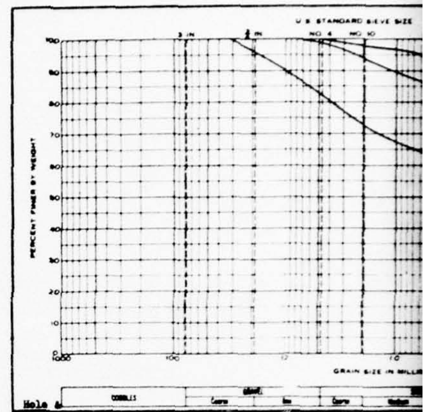
Project WHITE OAK CREEK D & R

Area Proposed Borrow

Boring No A62-1 through A62-8 (Bags)

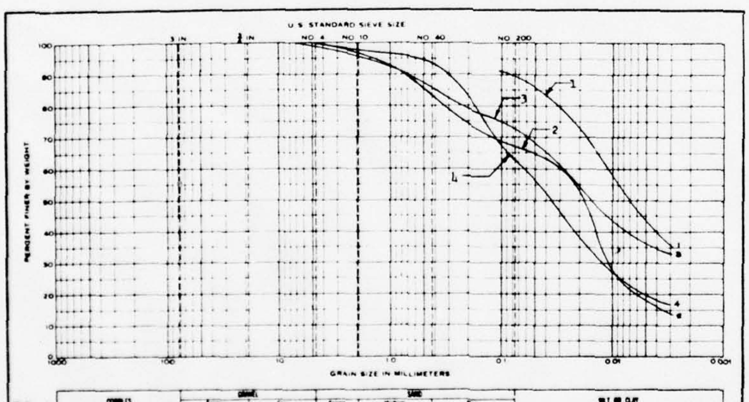
Date MAR 1963

GRADATION CURVES



Hole & Sample No	Elev or Depth	Classification	Nat WC	LL	PL	PI
A62- 9, Bag	1	Sandy CLAY (CL)		37.6	19.1	18.5
A62-10, Bag	1	Gravelly Sandy CLAY (CL)		37.5	19.7	17.8
A62-11, Bag	1	Sandy Silty CLAY (CL		25.7	16.2	9.5

GRADATION CURVES



Hole & Sample No	Elev or Depth	Classification	Nat WC	LL	PL	PI	indicated above as
A62- 1, #1	5.0	Lean CLAY (CL)	20.6	43.5	20.5	23.0	1
A62- 2, #1	5.0	Sandy CLAY (CL)	13.0	32.2	15.4	16.8	2
A62- 5, #1	5.0	Sandy CLAY (CL)	22.6	41.8	19.8	22.0	3
A62-11, #1	5.0	Sandy CLAY (CL)	19.4	30.1	16.3	13.8	4

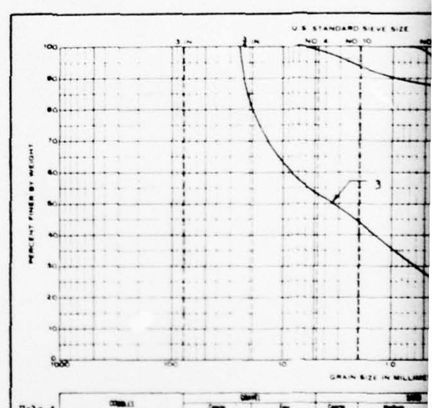
Project WHITE OAK CREEK D & R

Area Proposed Borrow

Boring No A62-1,2,5,11 (Jar Samples)

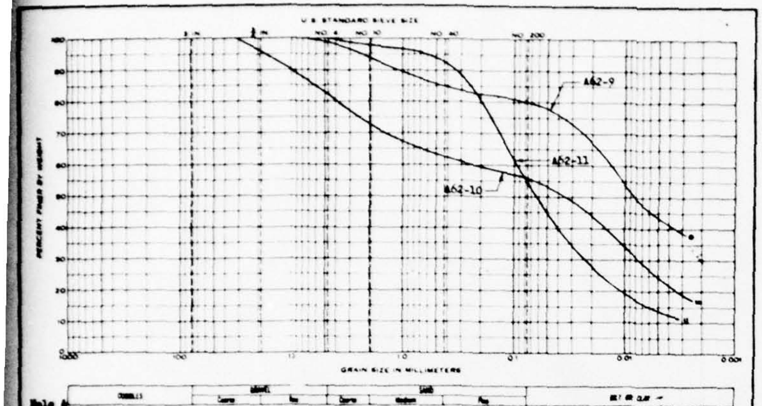
Date MAR 1963

GRADATION CURVES



Hole & Sample No	Elev or Depth	Classification	Nat WC	LL	PL	PI	indic
O62-3, #1	5.0	Lean CLAY (CL)	13.6	42.6	19.5	23.1	
O62-5, #3	4.0	Silty SAND (SM)	16.1		N-P		
O62-6, #2	4.0	Silty Sandy GRAVEL (GM)	-		N-P		

GRADATION CJRVES



Hole &

Sample No.	Elev or Depth	Classification	Nat WC	LL	PL	PI
A62- 9, Bag	1	Sandy CLAY (CL)		37.6	19.1	18.5
A62-10, Bag	1	Gravelly Sandy CLAY (CL)		37.5	19.7	17.8
A62-11, Bag	1	Sandy Silty CLAY (CL		25.7	16.2	9.5

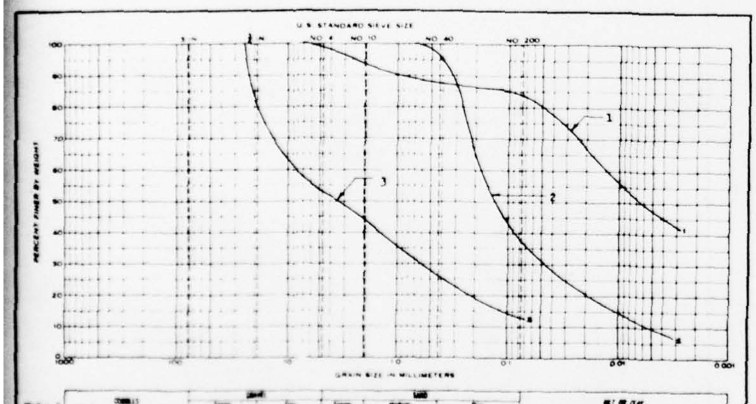
GRADATION CURVES

Project WHITE OAK CREEK D & R

Area Proposed Borrow

Boring No. A62-9, 10, 11

Date MAR 1963



Hole &

Sample No	Elev or Depth	Classification	Nat WC	LL	PL	PI	indicated above a
C62-3, #2	5.0	Lean CLAY (CL)	13.6	42.6	19.5	23.1	1
C62-5, #3	4.0	Silty SAND (SM)	16.1		N-P		2
C62-6, #2	4.0	Silty Sandy GRAVEL (GM)	-		N-P		3

GRADATION CJRVES

Project WHITE OAK CREEK D & R

Area Proposed Borrow

Boring No C62-3,5,6 (Jar Samples)

Date MAR 1963

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GRADATION CURVES

SCALE
AS SHOWN

EXHIBIT 14-20

AD-A041 396 CORPS OF ENGINEERS CINCINNATI OHIO F/G 8/6

DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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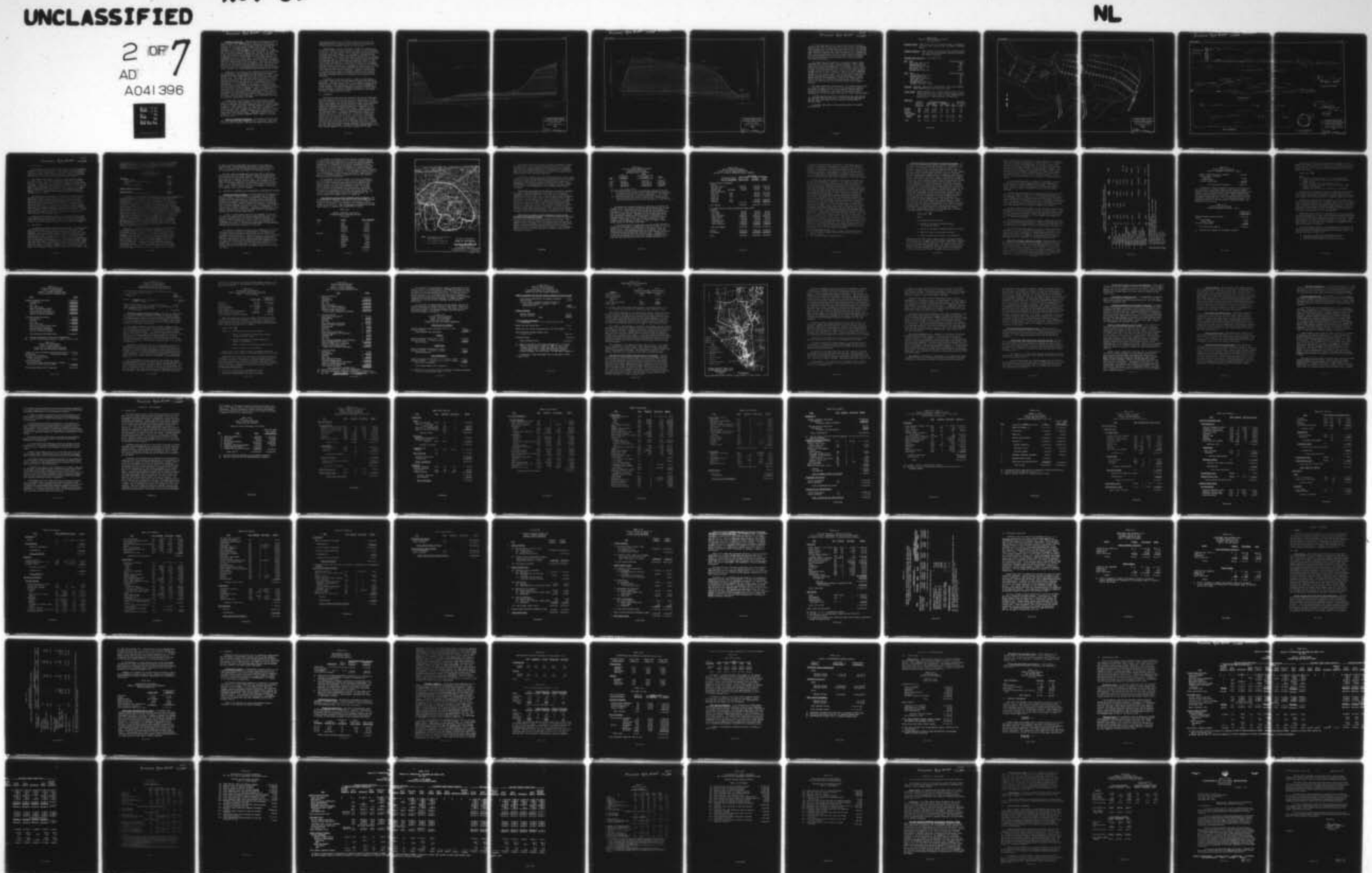

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Foundation conditions. Three NX-size core borings were drilled along the axis of the proposed dam in October and November 1962. These borings, C62-1, C62-4 and C62-5, were drilled to determine the character of the foundation and abutment rocks and character and thickness of overburden materials in the valley bottom. Slight weathering in the abutments ranges to depths in excess of 35 feet, some shale layers being weathered to soft clay seams. The shale also has air slaking properties. Boring C62-5, drilled in the valley bottom, indicates that the overburden is about seven feet thick and is composed of silty to sandy clays with a silty sand layer at an approximate depth of 3.5 to 4.0 feet. In the foundation this boring penetrated approximately seven feet of soft, gray, fissile weathered shale at a shallow depth in the flood plain. Overburden and weathered rock will be removed below the dam embankment and a double line grout curtain will be effected below the impervious zone. The depth of the grout curtain will be determined after future foundation explorations. Exhibit 14-21 shows a geologic section along the axis of dam.

Boring C62-2 was drilled at the original spillway site proposed for investigation. At the location of this boring, the depth of weathering extended approximately five feet below top of rock. Auger borings A62-7, A62-8, A62-9 and A62-10 were drilled near the former spillway area. The present spillway scheme is located in a natural ridgeline saddle about 700 feet west of the original spillway site. The spillway would be uncontrolled with a broad-crested weir at elevation 860. It is believed, in the scope of this report, that the materials to be encountered in the presently proposed spillway would be similar to that of boring C62-1 which is located approximately 1,000 feet east of the new alignment. Based on the general dip of the strata at the site, the projected strata from boring C62-1 to the proposed spillway appears to be approximately 25 feet higher in elevation. This projection infers that the spillway channel would be founded within an horizon existing of thin interbedded clay shale and limestone (approximately 60% shale).

Borings C62-1, C62-3 and C62-6 were drilled along the center line of the earlier tunnel alignment. The tunnel will be driven through a moderately hard shale containing thin hard limestone layers. The rock is closely jointed and the shale appears to have air slaking properties. Roof support within the tunnel will be provided by structural steel ribs. Seepage along the tunnel bore will be reduced by a three-ring grout collar at the approximate intersection of the center line of the dam and tunnel. A geologic section along the center line of the presently proposed tunnel alignment is included as Exhibit 14-22.

Source of Construction Materials. The bedrock at the dam site and in the reservoir area consists of soft to moderately hard shale with thin bedded limestone. The shale air-slakes fairly readily in

the recovered cores and it is believed unsuitable for use as rock embankment material. Because of this, an earth dam incorporating a random zone is considered feasible for this project.

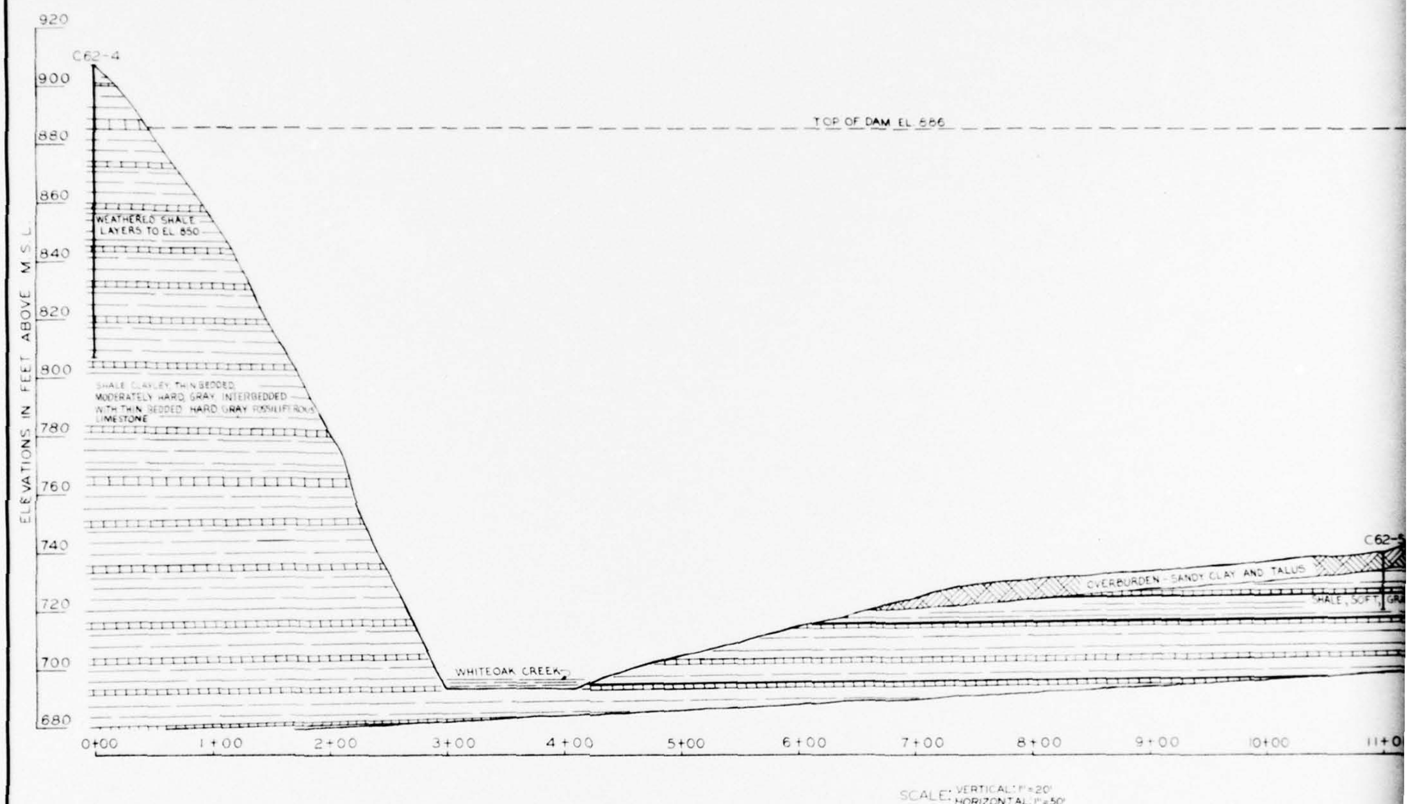
Approximately 4,150,000 cubic yards of impervious material and 299,000 cubic yards of random material are needed for the construction of the dam. Two areas located directly upstream, existing as terraces, have been drilled and sampled. It is estimated that approximately 2,000,000 cubic yards of impervious material are available in these two borrow areas. See exhibit 14-19 for the locations of auger borings in these borrow areas. Samples from these borings as well as samples of overburden from the core borings were logged and tested by Ohio River Division Laboratories. Laboratory test results of jar samples from borings A62-1, A62-2, A62-5 and A62-11 indicate that the natural moisture contents were equal to or exceeded the plastic limit for these materials. The need for further investigation and observations of these proposed borrow areas is apparent. A geologic reconnaissance of the road cuts and fills in the uplands adjacent to the dam site and logs of borings drilled in the area by other agencies revealed that earth embankment materials are available from the glacial till overburden.

Approximately 72,500 cubic yards of riprap and approximately 19,000 cubic yards of concrete are needed for the dam and appurtenant structures. The bedrock in the area of the proposed Whiteoak Dam and Reservoir shows little promise as a source of concrete aggregates or riprap because of the shale content and thin bedded characteristics of the limestone. The nearest commercial producers of quality aggregates and riprap are located at Hillsboro and Peebles, Ohio, about 40 miles by highway from the dam site.

11. STRUCTURAL

The site plan and structural features of the dam and appurtenant works are shown on Exhibits 14-23 and 14-24, respectively. The dam would be essentially a homogeneous section of rolled impervious earth, except that a random zone has been provided adjacent to the downstream slope to accommodate the spillway excavation. Ample quantities of compactible, impervious embankment material are available in four nearby and conveniently located borrow areas. Seepage through the embankment would be intercepted by an inclined drain separating the two embankment zones. A horizontal drainage blanket connects the inclined drain with the downstream toe. A positive seepage cutoff would be provided by a core trench cut into the rock. Foundation seepage would be controlled by a grout curtain which would extend across the valley floor and up the abutments. The entire upstream slope would be protected by dumped riprap three feet thick. Similar protection would be provided for the downstream slope up to elevation 735, four feet above maximum spillway tailwater; above elevation 735 the slope would be grassed. The dam would have a maximum height of 200 feet, a crest length of 1,650 feet and a top width of 32 feet.

CORPS OF ENGINEERS



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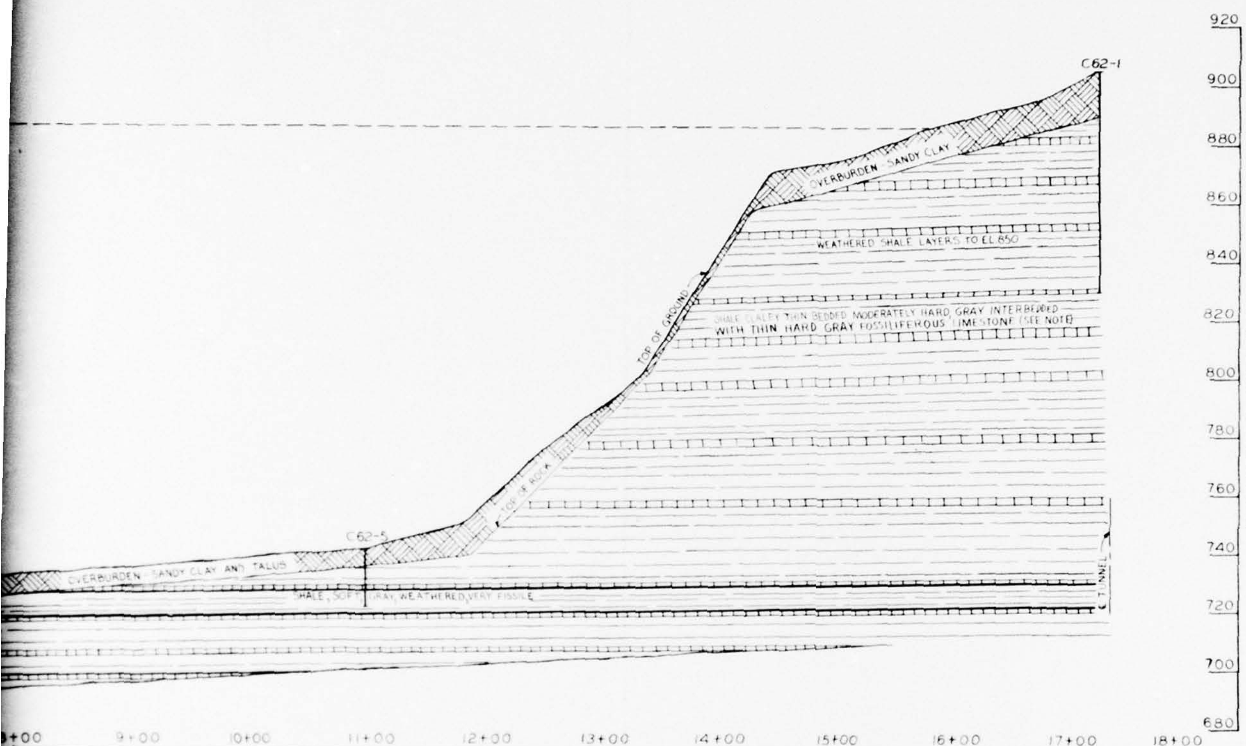

NOTE (1) SECTION SUPPLEMENTED BY BORING C62-3 LOCATED 640' SOUTH OF BORING C62-1

(2) BEDROCK SEQUENCE IS VARIABLY PREDOMINANTLY SHALE OR LIMESTONE

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GENERALIZED GEOLOGIC SECTION A-A'

SCALE: AS SHOWN

Drawn by: E.J.

Checked by: J.E.B.

Date: DEC 1963

EXHIBIT 14-21

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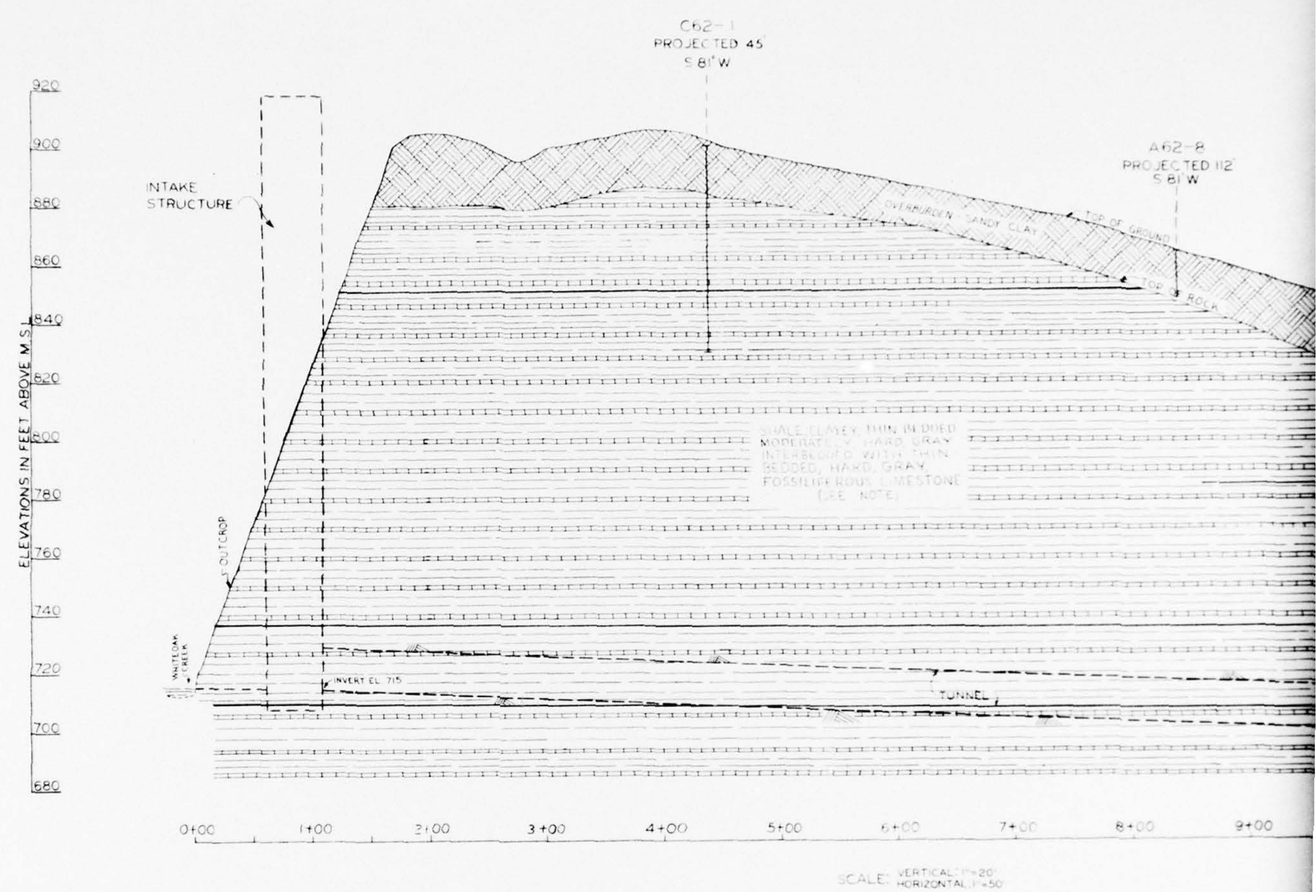
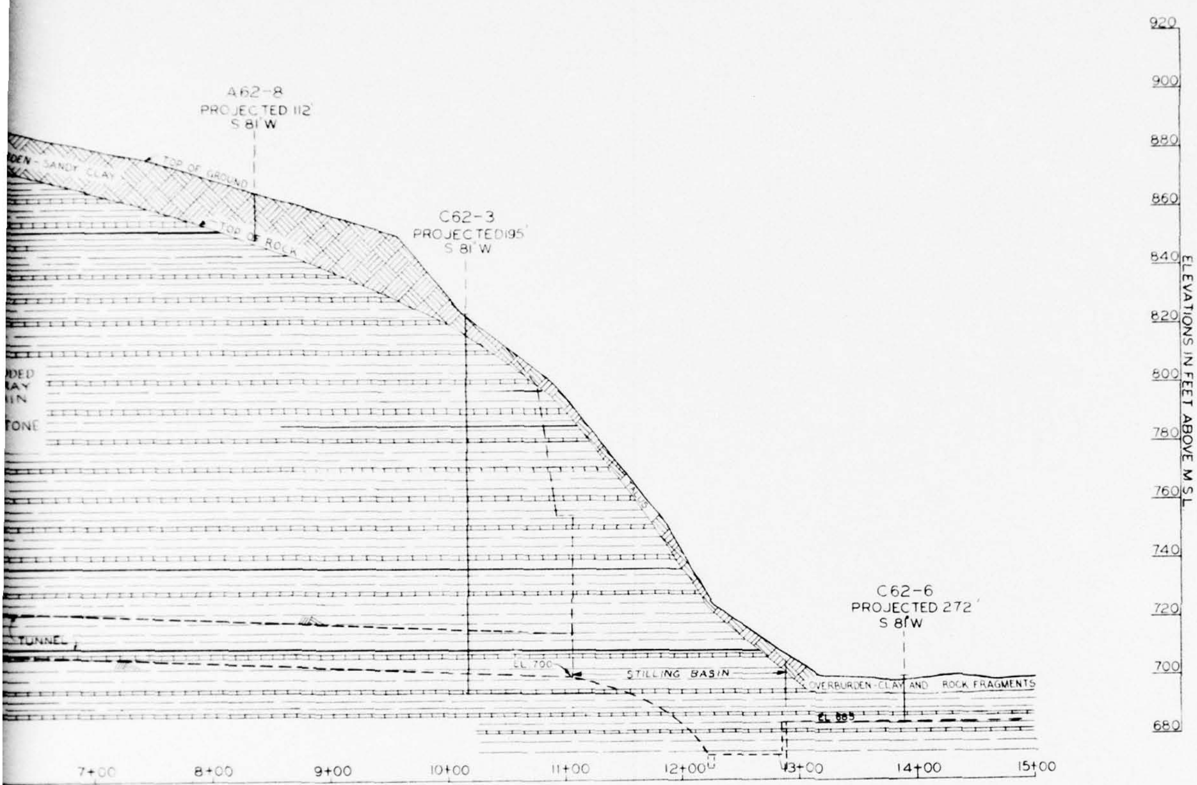
CORPS OF ENGINEERS





NOTE: BEDROCK SEQUENCE IS VARIABLY PREDOMINANTLY SHALE OR LIMESTONE

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

GENERALIZED GEOLOGIC SECTION B-B'

SCALE: AS SHOWN

Drawn by: ______

Checked by: ______

Date: DEC. 1963

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An uncontrolled spillway 500 feet in width would be excavated through a low ridge near the right abutment of the dam. The spillway would discharge into a ravine which would return the flow to Whiteoak Creek approximately 3,000 feet downstream from the dam. The spillway crest located at elevation 860, would be protected by a broadcrested weir. The slopes adjacent to the weir would be paved to elevation 885 for protection against scour during periods of spillway discharge. Both the broadcrested weir and the liner walls would be provided with anchors and drains.

The outlet works would consist of an approach channel, intake structure (with service bridge), tunnel transition, tunnel, tunnel outlet monolith, stilling basin, and outlet channel. All of these structures, except the extremities of the channels, would be founded on rock. The intake structure would be the wet well type and would be approximately 212 feet in height. Normal flow would be regulated through two 5'-8" x 10'-0" sluices and low flow would be controlled through a 30-inch diameter pipe. The multiple level intakes would provide temperature and oxygen control for maintenance of stream quality and fish life downstream. Access to the intake structure would be provided by an access road approximately 2,000 feet in length from Ohio Route 125, and a service bridge from the crest of the dam.

The tunnel transition, which begins at the upstream portal, would be 50 feet in length. The two 5'8" x 10'0" rectangular sluices at the portal are converted to a 14-foot diameter circular tunnel at the end of the transition. The concrete lined tunnel would be approximately 950 feet in length, including the tunnel outlet monolith.

The stilling basin would be the conventional jump type with one row of baffle blocks and end sill. An outlet channel approximately 400 feet long would return the flow from the stilling basin to Whiteoak Creek.

A pertinent data sheet for the proposed project is included as Table 14-18.

TABLE 14-18
WHITEOAK MULTIPLE-PURPOSE RESERVOIR
PERTINENT DATA

Location of dam: Brown County, Ohio, on Whiteoak Creek, a tributary of the Ohio River, 9.8 miles above the mouth of Whiteoak Creek.

Purpose of project: Flood control, water supply, water quality control, fish and wildlife enhancement, general recreation and economic expansion.

Drainage area controlled: 214 square miles.

Dam:	
Type	rolled earth fill
Top of dam, feet, m.s.l.	886.0
Maximum height, feet	200
Total crest length, feet	1,650
Top width, feet	32
Maximum base width, feet	1,460

Dike:	
Type	rolled earth fill
Top of dike, feet, m.s.l.	886.0
Maximum height, feet	36
Total crest length, feet	260
Top width, feet	12
Maximum base width, feet	310
Location, feet west of dam	350

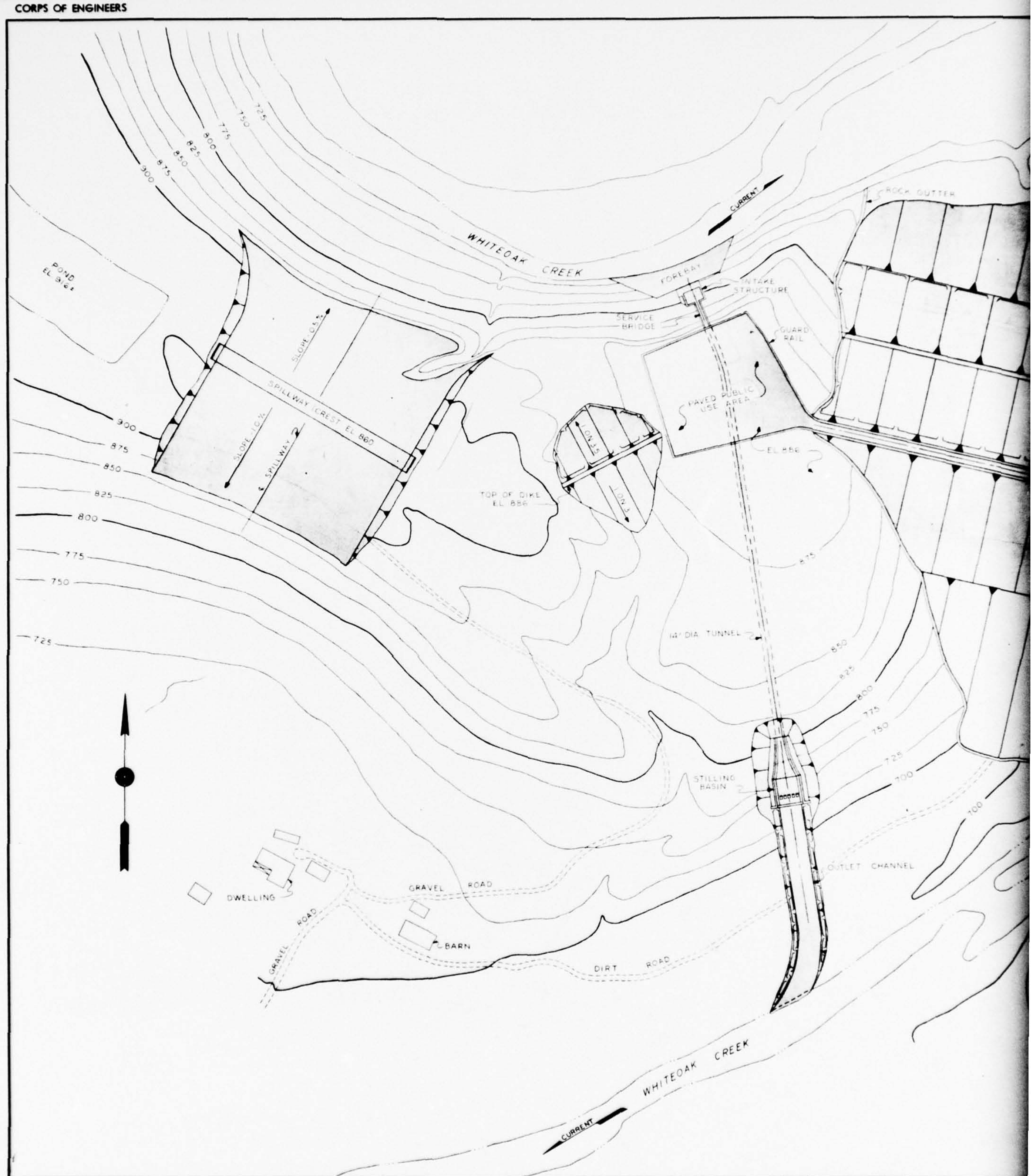
Spillway: Open-cut, uncontrolled, broadcrested in the right abutment, crest elevation 860, crest length 500 feet.

Outlet works: Intake structure with two gated sluices 5'-8" x 10'-0" and one 30" diameter low flow sluice discharging through a 14' diameter circular tunnel in right abutment into a stilling basin. Invert elevation 715 feet m.s.l.

Reservoir:

	Surface elevation ft., m.s.l.	Incremental Capacity Acre-feet Net	Incremental Capacity Acre-feet Accum.	Incremental Capacity Inches Net	Incremental Capacity Inches Accum.	Area acres	Backwater main stream miles
Minimum	786	9,500	9,500	0.8	0.8	320	4.4
Winter	814	14,900	24,400	1.3	2.1	741	6.6
Seasonal	826	10,100	34,500	0.9	3.0	931	7.5
Flood Control							
Seasonal	860	43,700	78,200	3.8	6.8	1,764	11.2
Winter	860	53,800	78,200	4.7	6.8	1,764	11.2
TOTAL	860	78,200	78,200	6.8	6.8	1,764	11.2

CORPS OF ENGINEERS



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

APPURTENANT WORKS
SITE PLAN

SCALE:
AS SHOWN

Drawn by: R.M.K.
Checked by: PMW BDR
Date: NOV. 1967

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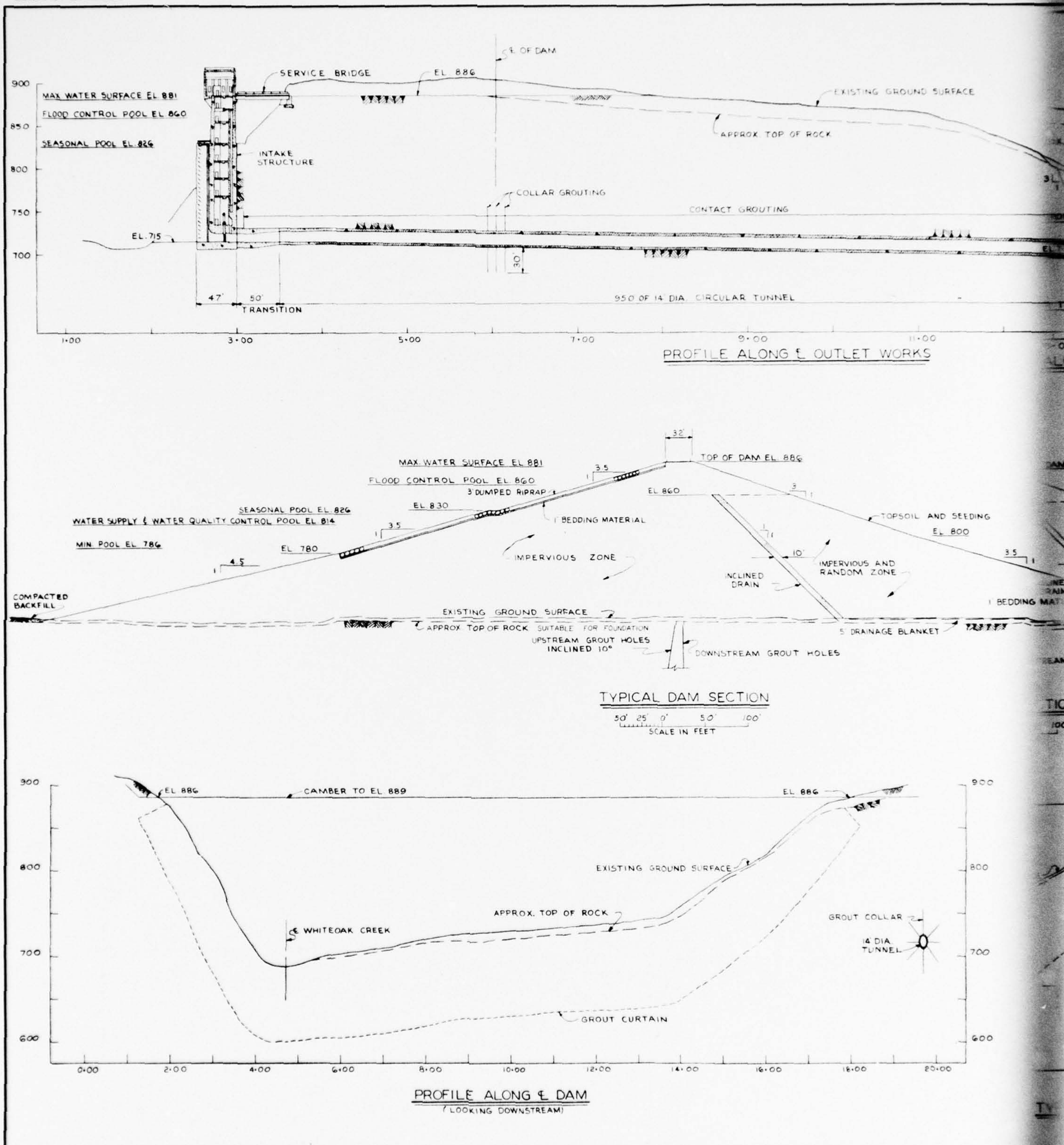
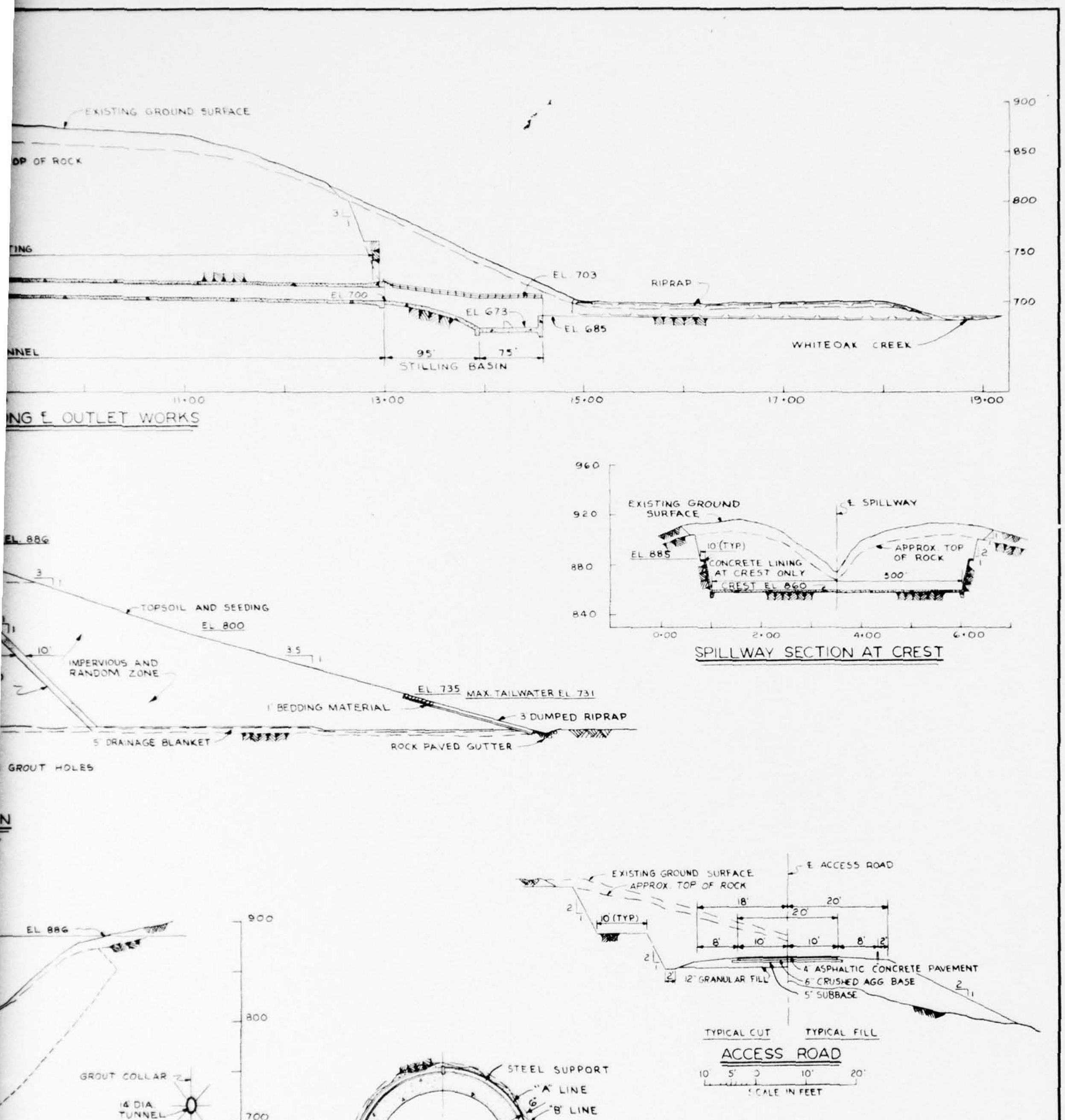
CORPS OF ENGINEERS





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WHITEOAK DAM AND RESERVOIR

APPURTENANT WORKS
PROFILE AND SECTIONS

SCALE
AS SHOWN

Drawn by: C.G.S.
Checked by: PMW BDR
Date: NOV. 1967

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12. RELOCATIONS

United States Route 68 and Ohio State Route 125 are the principal highways serving the project area. These highways are supplemented by county and township roads which provide access to private properties within and adjacent to the proposed reservoir. There is no existing railroad within the limits of the proposed Whiteoak Reservoir.

The project would require relocation of four miles of Federal and county roads. Some county and township roads may be abandoned but left in place, subject to flooding, for access to proposed recreation areas. County road relocations would be based upon State of Ohio, Department of Highways, minimum standards for construction of secondary roads. The cost estimate for relocation of U. S. Route 68 was based upon criteria used by the State of Ohio in the modernizing of that highway in 1960. A reservoir map showing the relocated highways is included as Exhibit 14-5.

Various utility lines would be affected by the proposed project requiring the relocation and removal of power transmission lines, distribution lines and miscellaneous telephone lines. The power facilities consist of one 345 kv transmission line owned by the Ohio Valley Electric Corporation; one 66 kv and two 33 kv transmission lines, and various 6.9 kv distribution lines owned by the Cincinnati Gas and Electric Company. Approximately 13 miles of rural telephone lines owned by the General Telephone Company of Ohio would be affected by the proposed project. These facilities consist of 2-wire to 12-wire open lines of standard construction. There are no known gas or oil lines affected by the proposed project.

There are eight cemeteries located in the proposed project area. These cemeteries, containing approximately 400 graves, would require relocation to suitable reinterment sites outside the project boundaries to avoid conflicts of usage and inconvenience to cemetery interests.

13. REAL ESTATE

The proposed reservoir would extend approximately 11 miles upstream along Whiteoak Creek, in the central portion of Brown County. Land acquisition for the multiple purpose project includes three basic categories: joint use, specific general recreation and specific refuge. Portions of the joint use lands would be used for general recreation. Other portions would be included in the refuge. The limits of the refuge lands were specified by the U. S. Fish and Wildlife Service and the Ohio Department of Natural Resources. The limits of general recreation lands were based on a generalized layout of recreation facilities and access roads. Sufficient peripheral lands were included to form a buffer to protect the aesthetic integrity of the recreation areas. The large size of ownership tracts in some cases dictated the extent of land

to be purchased in fee in lieu of severance. The resulting acreages available for general recreation exceed the minimum requirements estimated by the Bureau of Outdoor Recreation. A breakdown of real estate acquisition is given in Table 14-19.

TABLE 14-19
WHITEOAK DAM AND RESERVOIR
LAND ACQUISITION

	Acres
Joint Use	
Within refuge	2,000
Available for general recreation	2,300
Other	600
Total Joint Use	4,900
Specific general recreation	3,100
Specific refuge	5,500
TOTAL LAND ACQUISITION	13,500

The extent of joint use land acquisition and real estate interest to be acquired essentially would conform to the amended "Joint Policies of the Department of the Interior and the Army Relative to Reservoir Project Lands." The fee taking would be established by applying the criteria for acquisition to a minimum distance of 300 feet landward of the full flood control pool stage or to a vertical guide taking line five feet above that pool stage, whichever is greater. Fee title would be taken to the reservoir lands, refuge lands, dam and appurtenances and highway relocation sites, along with the entireties of properties which would be unduly severed or left without reasonable access. Exceptions to this general policy would be in remote areas of the project where, due to infrequent flooding, it is considered to be in the best interest of the Government to acquire flowage easements. Specific lands to be acquired for the refuge and for recreation development purposes would lie outside the minimum taking limits. Actual acreage requirements will be determined by further detailed studies for each of the special purposes, following authorization. All mineral rights, if any, would be acquired.

The area of the proposed reservoir, classified economically as a depressed area, adjoins the Village of Georgetown, Ohio, the county seat of Brown County, and is but a short distance from the perimeter of residential growth of the City of Cincinnati, Ohio. Generally, the topography of the land is mostly rolling hill land to level bottom land with the exception of Whiteoak Creek itself, which is quite steep and rugged along approximately 40% of the reservoir area. Most of the properties are farms in the 25 to 400 acre size range. Some small acreage properties are used for residential purposes. Improvements appear to be well maintained. The present use of most of the land is for agriculture. Cropland is in good condition and among the main crops are corn and tobacco.

No specific trends of development were noticed in the proposed reservoir area. Some residential development, however, was noted east of the project area near Georgetown along Ohio State Route 68 to the north and off Ohio State Route 125 to the west of town.

The unit values and average per acre values used in the gross appraisal are based upon recent transacted sales of comparable lands in the vicinity of the proposed project. The values of any marketable timber are included in the land value. With the amount of recent sales available, a thorough study was made of the immediate area in regard to this gross appraisal. No consideration was given to growing crops. It is assumed that the owners will be allowed to harvest the year's crops. There is nothing to indicate any change or improvement in the present use of lands or buildings.

14. RECREATION - DEVELOPMENT AND CONSERVATION OF ENVIRONMENTAL RESOURCES

Purpose and Scope of Studies. Set forth here are the descriptions and conclusions of studies conducted to formulate plans for general outdoor recreation, fish and wildlife conservation, general project management and the preservation of historical, scenic, archeological, ecological and geological resources associated with the Whiteoak Dam and Reservoir Project. Brought together are the views of the Department of Natural Resources, State of Ohio, the Bureaus of Outdoor Recreation and Sport Fisheries and Wildlife of the U. S. Department of the Interior and the Corps of Engineers. Adjustments have been made in the general recommendations of each participant in order to accommodate a resource use plan of widest human benefit.

It should be particularly noted that the character of the plans presented here departs from the access-oriented concepts that have in the past accompanied such water resource development proposals. In response to the requirements of Public Law 89-72, these plans were formulated with a view to meeting modern state park standards and administrative criteria of the principal participants in the financial operation and maintenance obligations of the plan.

The data and information utilized in the formulation of the plans contained herein are derived from many sources. The physical plans for general outdoor recreation, and fish and wildlife conservation, enhancement and preservation are based on site studies by the cooperating agencies of sufficient depth to support survey-scope recommendations. Extensive compilation of outdoor recreation demands, and the nature and capacities of existing and planned projects and programs have been accomplished. These studies were limited in scope sufficient to determine short and long range needs for capacities available on the Whiteoak Project and the physical and economic feasibility of meeting such needs.

The present study directs its main emphasis to determining the equivalent capacities represented by (1) outdoor recreation demand, (2) outdoor recreation capacities of present and future projects and programs, and (3) comparisons of the two as a measurement of needs. Detailed scrutiny of the outdoor recreation mix of activities, while recognized as a critical element in planning, is properly reserved for stages of detailed project site planning, should project feasibility and authorization be established. It is considered a principal function of the present study to determine needs and project feasibility as a basis for recommending project authorization and the more detailed planning leading to construction.

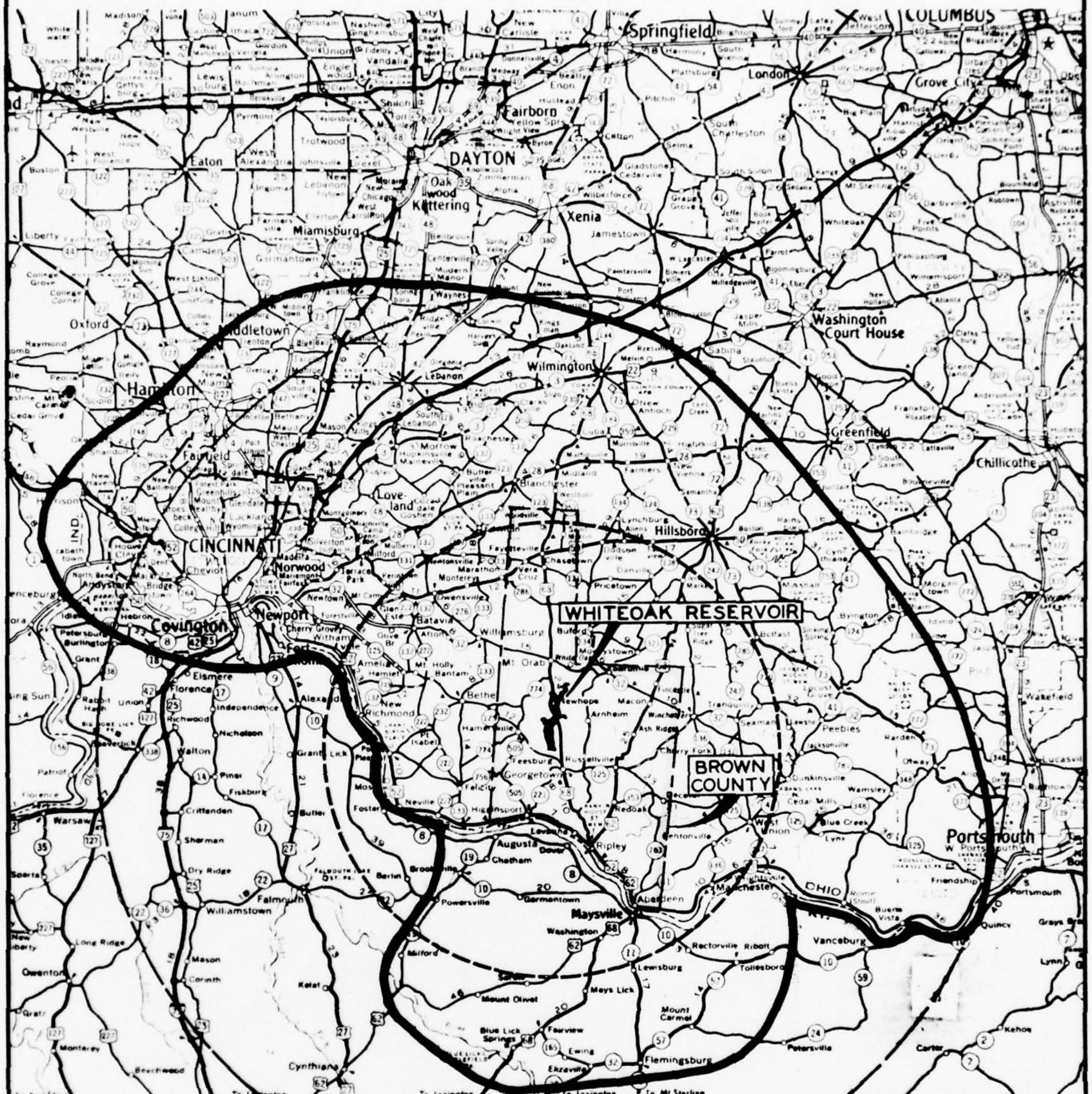
The objectives of the study reside in an effort to formulate a plan of development that would (1) meet local and regional requirements for outdoor recreation needs resulting from population and economic growth, (2) offer added incentives in the form of high-quality community recreation in attracting industry to the area, and (3) attract "out-of-Appalachia" recreationists, vacationists and tourists to the area in such numbers and for such duration as to result in an enhancement of the local and regional economy. The bases for the economic determinations are presented here. The economic effects are treated in Part II, Chapter 14.

Characteristics of the Project Recreation Area of Analysis. The recreation area of analysis is the physical zone of municipal, general outdoor recreation influence as defined by the Bureau of Outdoor Recreation in Appendix F. The boundary of the recreation zone of influence, shown on Exhibit 14-25, encompasses six counties in Ohio and eight counties in Kentucky with populations as follows:

TABLE 14-20

COUNTIES COMPRISING THE PHYSICAL RECREATION ZONE OF INFLUENCE AND 1960 POPULATIONS

State	County	1960 Population
Ohio	Brown	25,178
	Adams	19,982
	Highland	29,716
	Clermont	80,515
	Hamilton	864,121
	Clinton	30,004
Kentucky		
	Kenton	120,700
	Campbell	86,803
	Pendleton	9,968
	Robertson	2,443
	Bracken	7,422
	Mason	18,454
	Fleming	10,890
	Lewis	13,115
Total		1,319,311



APPROXIMATELY 1-HOUR DRIVING TIME FROM DAM SITE

25 MILE RADIUS OF DAM SITE

50 MILE RADIUS OF DAM SITE

WHITEOAK RESERVOIR

ZONE OF INFLUENCE

10 0 10 20 30

SCALE IN MILES

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. JAN. 1968

The persons residing in the above counties are expected to exert the major impact on the outdoor recreation resources of the project. The analysis of demands, capacities of existing facilities serving them, and future needs associated with this population is emphasized here, although experience shows that the effects of the project will be substantially more widespread regionally.

The Whiteoak Reservoir would be located on Whiteoak Creek in Brown County, Ohio, about one mile northwest of Georgetown, Ohio. The project is within an hour's driving time of Cincinnati, and is capable of supporting a wide variety of outdoor recreation activities. Planned improvements to the highway network will increase the accessibility of the project for the residents of the recreation market area of influence.

The Whiteoak Creek Basin is well served by a network of highways. U. S. Route 52 passes through the lower portion of the basin at Higginsport connecting Cincinnati to the west and the Portsmouth-Huntington area to the east. U. S. Route 68, lying within the western section of the basin, runs parallel to the Whiteoak Reservoir site and connects with the Dayton, Ohio, area to the north. U. S. Route 62 passes to the east of the basin in a general north-south direction connecting Columbus with Ripley, which is located southeast of the basin. State Roads 125, 32, 131 and 134 bisect the basin at various locations. Appalachian Corridor "D" highway is presently in the advanced planning stage of development. This highway, when completed, will pass through the northern portion of the basin and will connect Cincinnati to the west with the Baltimore, Maryland, area to the east.

Determination of Needs for Outdoor Resource Products of the Whiteoak Dam and Reservoir Project. The expected population increases, both within and outside Appalachian counties, but within the zone of influence of the Whiteoak Project, are shown in Table 14-21. The economic growth that will involve the environment of these people is treated in detail elsewhere, but the expected increase in real income, change in employment patterns, increased mobility, and increased leisure time are all factors expected to contribute to an increasing demand per capita for outdoor recreation to meet the needs of this increasing population.

TABLE 14-21
WHITEOAK DAM AND RESERVOIR PROJECT
POPULATION PROJECTIONS
RECREATION AREA OF ANALYSIS

Year	Six Appalachian Counties	Eight Outside Appalachian Counties	Total
1960 1/	179,396	1,139,915	1,319,311
1980	227,000 2/	1,551,000 3/	1,778,000
2000	314,000 2/	2,109,000 3/	2,423,000
2020	434,000 2/	2,805,000 3/	3,239,000

1/ U. S. Census Report 1960.
2/ Population projections for the Appalachian counties in the zone of influence were derived from the total Appalachian population benchmark projections for Economic Sub-region 9. (See Appendix E)
3/ Population projections for the Non-Appalachian counties in the zone of influence were derived from the total Non-Appalachian population projections for Economic Sub-region 9. (See Appendix E)

The present and projected recreation capacities of projects and programs within the 14-county recreation area of analysis are included in Table 14-22. These data show that the present and forecasted capacities of all known projects and programs are substantially less than the projected demand. Consequently, the planning requirement that alternative sources be studied as possible substitutes for the Whiteoak Project is eliminated. It generally is conceded, and all available figures bear it out, that the gross demand for outdoor recreation may be expected to exceed the supply in areas of urban growth typical of the present study area.

As indicated earlier, the population of the principal recreation market area is expected to increase from 1,319,300 in 1960 to 3,239,000 people in 2020. Since about 86 percent of the people of this area reside outside of the Appalachian area, and 82 percent within the Cincinnati Standard Metropolitan Statistical Area, certain conclusions of the over-all Appalachian Study would not apply. Consequently, national participation rates in all major outdoor recreation activities have been substituted for both the "selected activities" and

TABLE 14-22
WHITEOAK DAM AND RESERVOIR
FEDERAL AND NON-FEDERAL RECREATION
CAPACITY OF 14-COUNTY RECREATION AREA OF ANALYSIS

	Estimated Initial Year of Impoundment	Visitation 1967 or Most Recent Year	Initial Increment	Ultimate Total
Federal (Corps of Engineers)				
Complete				
West Fork Mill Cr.		1,560,500	1,560,500	1,560,500
Markland L&D		226,600	226,600	226,600
Meldahl L&D	Estimated	226,600	226,600	226,600
Under Construction				
East Fork	1973		837,000	2,650,000
Caesar Cr.	1973		685,000	2,150,000
Paint Cr.	1972		250,000	410,000
Authorized				
Eagle Cr.	1975		300,000	1,000,000
Falmouth	1975		750,000	1,080,000
Total Federal		2,013,700	4,835,700	9,303,700
Non-Federal (State of Ohio and Hamilton County, Ohio)				
Complete				
Pike Lake		230,000	230,000	230,000
Lake White		158,300	158,300	158,300
Rocky Fork Lake		1,281,800	1,281,800	1,281,800
Hueston Woods		1,589,400	1,589,400	1,589,400
Cowan Lake		767,800	767,800	767,800
Stonelick Creek		536,700	536,700	536,700
Sharon Woods		1,418,000	1,418,000	1,418,000
Miami Whitewater		196,900	196,900	196,900
Total Non-Federal		6,178,900	6,178,900	6,178,900
Federal		2,013,700	4,835,700	9,303,700
Non-Federal		6,178,900	6,178,900	6,178,900
Total		8,192,600	11,014,600	15,482,600

"all activity" rates utilized for analysis of the demand inherent in populations residing in Appalachia. As indicated in appropriate footnotes of Table 14-23, all basic participation rates are from published data supplied by the Bureau of Outdoor Recreation 1/ which is based on that part of the population 12 years of age and above. This total magnitude of participation is retained here but converted to its total per capita of population equivalent, because data from outside of Appalachia are more readily available in the converted form.

In order that these participation rates may be consistent with the required methodology for benefit - cost analysis, project formulation, and cost allocation procedures, they have been converted from activity days to equivalent recreation or visitor days for units of measurement. These data are presented in Table 14-23 which shows that the demand for outdoor recreation for all major activities will exceed the existing and planned capacities by 24,335,000 recreation or visitor days by 1980. By 2020, this excess of demand over foreseeable supply would amount to over 78 million recreation or visitor days. The Outdoor Recreation Resources Review Commission, Report 19 2/, indicates that of the time spent away from home in pursuit of some form of outdoor recreation, 14% occurred as overnight trips and 42% as day use outings. Recent studies in the Muskingum River Basin 3/, indicate further that some 60% of this visitation occurs on the weekend. It is therefore reasonable to assume that in 1980 within the market area of this project, there will be generated, and largely unsatisfied, about eight million recreation days which would be satisfied on the weekend provided that the necessary supply is available. Much of this unsatisfied demand will remain within the market area. As indicated by the Muskingum study, wherein it was found that 65% of visitation originated within one hours driving time of the project, 5,300,000 of the eight million unsatisfied recreation days are considered pertinent to the project. The design of the recreation development is intended to reflect this great need. The capacity which would be supplied by the Whiteoak Reservoir of 950,000 visitor days is expected to be utilized within the first three year period after construction. The principal administrative problem foreseen is control of use sufficient to prevent over-use and despoilation of the scenic and sanitary quality of the proposed development.

1/ U. S. Department of the Interior, Bureau of Outdoor Recreation. The 1965 Survey of Outdoor Recreation Activities, October 1967.
2/ Table 17, page 61.
3/ 1967 Recreation Survey, Muskingum River.

Alternative Plans for Environmental Resources Development. In arriving at an optimum plan of outdoor recreation development, two alternative plans for the Whiteoak Reservoir are considered in this analysis. One, defined as the Plan of Maximum Economic Yield, presents a design to serve the maximum number of people under conditions of acceptable modern park standards (Plan A - Without Refuge). The other (Plan B - With Refuge) defined as the Plan of Optimum Resource Use presents a design wherein the number of people directly served is substantially reduced in order to accommodate a recommendation of the State of Ohio that a Canada Goose Inviolate Refuge and Rearing Unit, and an adjacent managed public hunting area be included in the formulation of the Whiteoak Project which would yield conservation benefits not totally identifiable in monetary equivalent, and which would have regional and national significance. Development costs will be relatively high in either plan as a result of the topography, the extent of development, and additional capacities required to meet the large visitation expected on the weekend. The recreational development in both plans has been designed to meet a massive and growing need for day-use facilities within the zone of influence. Much of this demand is expected on weekends and with the recommended plan, fully half of the weekly visitation is expected on the "Normal Summer Sunday." The design load, number of facilities and cost of development are somewhat greater in these plans than will be found in plans designed to accommodate a visitation more evenly distributed throughout the week. The relationship between numbers of facilities and the expected annual use of those facilities is more clearly defined by the design load formula. Design load, the maximum number of visitors expected at any moment on a summer Sunday, is calculated as follows:

$$\text{Design Load} = \frac{Aad}{wt}$$

Where:

A = Estimated annual visitation

a = Percent of the annual visitation during the recreation season.

d = Percent of the weekly visitation expected on Sunday

w = Number of weeks in the recreation season

t = Daily turnover rate of users of the facilities

Assuming that all other factors remain constant including estimated annual visitation, the magnitude of the design load becomes a function of the percent of the weekly visitation which is expected on Sunday and of the assumed daily turnover rate. The number of facilities for example, which will accommodate one-half the weekly visitation must be about 50 percent greater than the number which will accommodate one-third the weekly visitation. Assuming the same daily use, a

daily turnover rate of 2 results in a design load which is 25 percent less than the design load assuming a turnover rate of 1.5. Recreation costs are related to the design load. An increase in design load produces an increase of some magnitude in the costs. As the design load increases in relationship to a constant annual visitation, costs per visitor day increase. Given the same resource, a change in the visitation is not necessarily accompanied by a change in the quality of the experience. Quality, at least insofar as it is affected by the number of users, is a function of the design density. In this respect, either plan provides for an experience of exceptionally high quality.

The recreation potential of a reservoir is primarily a function of the amount of recreation land available and the design density or the intensity of the development on these lands. The design density varies as the ratio of developed to undeveloped recreation lands, and as the number of facilities varies on the land areas developed.

Assuming that any plan worthy of consideration will provide facilities for the number of users not to exceed the carrying capacity of the topography, soils, ecology, etc., the intensity of the development, i.e. the design density, is more indicative of the kind of experience than of the quality of experience. The ratio of developed to undeveloped lands, the proximity of the developed areas, and the density of facilities each have an affect on the design density of the development and each a profound affect on the general atmosphere in the park.

The more intense the development the more strongly the park becomes people-oriented and the more important become the social aspects of the development. On the other hand, the less the intensity of the development the stronger the orientation toward the resource and the greater the importance of those aspects of the development which enhance the people - resource relationship.

In either plan, with or without the refuge, recreational development has been minimized and disbursed to reduce the dis-orienting effect of excessive contact between users and to provide every opportunity for the individual to enjoy space, nature and an uncluttered environment.

The ratio of developed lands to total acres of land available is less than 1 in 10 acres, and the design density of facilities is not greater than half that achieved by standard spacing criteria. Annual visitation in Plan A is estimated to be 1/3 more than with Plan B. However, Plan B with the refuge is recommended and the two plans are presented herein for comparison of costs and beneficial yields.

Evaluation of Plan A - Without the Refuge. Whiteoak Reservoir, if developed to its maximum capacity for general recreation without the refuge, would provide general recreation opportunities for 1,300,000 visitor-days annually. Fish and wildlife-oriented visitation would total 76,000 visitor-days annually. This visitation to the project would be reached within three years after project completion. These values as shown in Table 14-24 include sightseers and fish and wildlife visitation. The fish and wildlife data are based on preliminary information furnished by the U.S. Fish and Wildlife Service.

TABLE 14-23

DERIVATION OF ESTIMATE - OUTDOOR RECREATION NEEDS

RECREATION AREA OF ANALYSIS -WHITEOAK DAM AND RESERVOIR 1/

Item		1960	1965	1980	2000	2020
1. Total U. S. Cont. pop. (Million)	2/	181	195	245	338	
2. Recreation Activity Days (Million)	3/	4,282	6,476	10,128	16,846	
3. Recreation Days (Million)	4/	2,141	3,238	5,064	8,413	
4. Recreation Days / Capita Rate	5/	11.8	16.6	20.6	24.8	28.9 6/
5. Population of Recreation Market Area (1,000's)	7/	1,319		1,778	2,422	3,239
6. Recreation Demand Market Area in (1,000's Rec Days)	8/	15,600		36,635	60,085	93,604
7. Capacity of Projects and Programs - Recreation Market Area (1,000's Rec Days)	9/	6,400 6/		12,300 6/	14,800 6/	15,500 6/
8. Demands Not Met By Federal & Non-Federal Programs (1,000's Rec Days)	10/	9,200		24,335	45,285	78,104

1/ 16 Major Summertime Outdoor Recreation Activities -- Outdoor Recreation Trends - BOR 1965 Survey
2/ Statistical Abstract 1965, page 6
3/ Activity Days from Recreation Trends - BOR 1965 Survey
4/ Activity Day Conversion Factor of 2.0
5/ Recreation Days ÷ Total Population = Per Capita Rate
6/ Interpolated
7/ See Table 14-21
8/ Item 4 X Item 5
9/ See Table 14-22
10/ Item 6 - Item 7

TABLE 14-24
WHITEOAK DAM AND RESERVOIR
SUMMARY OF RECREATION VISITATION - PLAN A

General recreation annual visitation	1,300,000
Fishing annual visitation:	
Impoundment	56,400
Stream fishery	900
Wildlife (upland game)	18,700
Total Recreation Visitation	1,376,000

In response to quality standards, a value of $1.25 per visitor day was adopted as an average annual benefit figure for general recreation use. Applying this figure to the estimated annual attendance of 1,300,000 visitors gives a total average annual general recreation project benefit of $1,625,000. Benefit values for fish and wildlife activities, which vary by type, are based on planning information provided by the U. S. Fish and Wildlife Service. Both general recreation and fish and wildlife recreation benefits are summarized in Table 14-25.

TABLE 14-25
WHITEOAK DAM AND RESERVOIR
SUMMARY OF RECREATION BENEFITS - PLAN A

	Average annual benefits
General recreation annual benefits	$ 1,625,000
Fishing	
Impoundment	56,400
Stream fishery 1/	2,100
Wildlife (upland game)	41,900
Total Recreation Benefits	$ 1,725,400

1/ Includes both upstream and downstream fisheries

Preliminary recreation site locations were developed in order to estimate the capacity of the Whiteoak Project for maximum use. In the siting, scaling, and design of the recreational facilities required to make optimum use of the terrain, loading was determined by use of the design load concept.

$$\text{Design load} = \frac{Aad}{wt}$$

Where:

A = Estimated annual attendance (visitor days)(1,300,000)
a = Percent of attendance visiting project during recreation season (58%) 1/
w = Number of weeks in recreation season (13) 2/
d = Percent of weekly attendance expected on a normal summer Sunday (33 estimated)
t = Turnover rate of daily use of facility (1.5 estimated)

Application of this equation results in a general recreation visitation design load for Whiteoak Reservoir of about 13,000 visitors. This design load was used to estimate the type and quantity of facilities to which unit costs were applied to determine total facility costs.

Multiple level intakes would be provided to control depth from which releases are made in order to regulate oxygen content and temperature for fishing enhancement and for water quality control. The access roads, launching facilities and parking spaces needed for fishing and hunting would be provided for general recreation purposes and would be sufficient for both functions since the peak usage for the different activities normally would not occur simultaneously.

Additional lands consisting of approximately 4,950 acres located around the periphery of the basic project would be acquired specifically for recreation and would be used jointly between the general recreation and the fish and wildlife enhancement purposes of the project. Enough land downstream from the dam would be provided for an adequate tailwater fishery. The following tables summarize cost elements of Plan A - Without the Refuge for comparison.

For cost allocation purposes, the average annual alternative cost for equivalent single-purpose recreation was derived through application of statistics for similar developments in the State of Ohio. The derivation is shown in Table 14-28.

1/ From study of visitation in Muskingum River Basin Muskingum Watershed Conservancy District 1967
2/ Recreation season assumed to be June, July, August

TABLE 14-26
WHITEOAK DAM AND RESERVOIR
PLAN A - WITHOUT REFUGE
SUMMARY OF GENERAL RECREATION AND
FISH AND WILDLIFE INVESTMENT COSTS

Item	Total
General recreation facilities	$ 13,000,000
Contingencies	1,950,000
Subtotal	$ 14,950,000
E&D - S&A	2,645,000
Total facilities	$ 17,595,000
Specific Recreation Lands 1/	2,883,200
Total lands and facilities	$ 20,478,200
Interest during construction 2/	1,331,000
General recreation investment	$ 21,809,200
Fish and wildlife facilities	$ 520,000
Contingencies	80,000
Subtotal	$ 600,000
E&D - S&A	106,000
Total facilities	$ 706,000
Specific fish and wildlife lands	0
Total lands and facilities	$ 706,000
Interest during construction	46,000
Fish and wildlife investment	$ 752,000
TOTAL RECREATION INVESTMENT COSTS	$ 22,561,200

1/ Includes administrative costs and contingencies.
2/ One-half of construction period of 4 years @ 3.25% = 6.50%

TABLE 14-27
WHITEOAK DAM AND RESERVOIR
PLAN A - WITHOUT REFUGE
DERIVATION OF AVERAGE ANNUAL COSTS FOR
GENERAL AND FISH AND WILDLIFE RECREATION

Interest on gross investment	($22,561,200)(0.0325) =	$ 733,200
Amortization	(22,561,200)(0.00138)=	31,100
Operation and maintenance (Annual visitation) (0.20) (1,376,000) ($0.20)	=	275,200
Major replacements (One-third of total facilities every 25 years) ($15,550,000)(1/3)(0.7424)(0.03388)	=	130,400
TOTAL AVERAGE ANNUAL COSTS (financial)		$1,169,900

TABLE 14-28
WHITEOAK DAM AND RESERVOIR
PLAN A - WITHOUT REFUGE
ALTERNATIVE ANNUAL COST DERIVATION FOR
GENERAL AND FISH AND WILDLIFE RECREATION

Land acquired specifically for recreation 4,950 acres plus 4,019 acres of joint use land	8,969
Recreation Pool	931
TOTAL	9,900 acres

Density = $\frac{1,370,000 \text{ (annual attendance)}}{9,900 \text{ (acres)}}$ = 139 visitors/acre

Annual cost per visitor day in average 1960 prices = $ 0.695
Annual cost per visitor day escalated to July 1967 prices =$ 0.91
TOTAL AVERAGE ANNUAL ALTERNATIVE COST
1,376,000 x $0.91 = $1,255,000

Evaluation of Plan B - With the Refuge. When Plan A, emphasizing recreation development, is modified to include the proposed refuge, the capability of the project for meeting general recreation demands is somewhat reduced. Thus, the general recreation plan developed for Plan B is less extensive than with Plan A. Development costs, number of facilities and recreation visitation have all been reduced proportionally by 25 percent to 30 percent.

All interests consider the project to offer a somewhat unique experience because of the variety of activities available in the proximity of a major metropolitan area. The user areas would be unusually well developed and maintained. It, therefore, was considered appropriate, as in Plan A, to apply a monetary unit benefit value of $1.25, which is in the upper bracket of the range provided for by Senate Document No. 97. A major factor in selecting this unit value per recreation-day was the recognition of the extreme scarcity of outdoor recreation facilities in the Cincinnati region relative to its increasing population.

Application of the $1.25 unit value to the annual visitation of 950,000 general recreationists results in average annual benefits of $1,187,500. Benefits deriving from adoption of the Goose Refuge Plan proposed by the State of Ohio, Department of Natural Resources, and contained in the U. S. Fish and Wildlife Service recommendations would include waterfowl, hunting, production and preservation of migratory geese, sightseeing, nature study and photography in the goose management unit.

The establishment of a major migratory goose refuge and managed hunting area would offer the recreation visitor a unique experience. A comprehensive interpretive program is planned with guided tours, show ponds, an observation tower, and nature trails. The establishment of such a refuge would tend to lengthen the recreation season at this project and extend use of such facilities as the campgrounds into the fall hunting season. The opportunity for schools to use the interpretive

facilities at the refuge as a field laboratory appears unlimited. The man-days of usage and the corresponding net annual benefit values are given in Table 14-29.

TABLE 14-29
WHITEOAK DAM AND RESERVOIR
SUMMARY OF RECREATION BENEFITS AND VISITATION
PLAN B - WITH THE REFUGE

	Visitor Days	Average-annual Benefits
Recreation	950,000	$1,187,500
Fishery	13,560	13,560
Upland hunting	(No increase)	-
Waterfowl hunting	6,500	37,600
Nature study, etc.	43,500	87,000
Goose production and preservation	-	124,300
Total recreation visitation	1,013,560	
Total recreation benefits (rounded)		$1,450,000

With the refuge, the plan of development for general recreation envisions a well developed complement of facilities to best suit the character of the project. Facility sizing was based on design load factors derived from compilation of data from similar existing developments. Design load factors are as follows:

$$\text{Design load} = \frac{Aad}{wt}$$

Where: A = Estimated annual visitation, 950,000

a = Percent of attendance visiting project during recreation season (58) 1/

d = Percent of the weekly visitation expected on Sunday (50 estimated)

w = Number of weeks in the recreation season (13) 2/

t = Daily turnover rate (2.0 estimated)

Application of this equation results in a general recreation visitation design load of 10,600 for Whiteoak Reservoir with the refuge.

Approximately 5,400 acres of land would be utilized for general recreation. Of this total, 3,100 acres would be acquired specifically for general recreation. This amount of specific lands exceeds the quantity suggested by the Bureau of Outdoor Recreation partly because of the large size of tracts involved and partly to provide a peripheral buffer to maintain the aesthetic integrity of the project and the assigned unit benefit value.

1/ From study of visitation in Muskingum River Basin, Muskingum Watershed Conservancy District, 1967
2/ Recreation season assumed to be June, July, August.

TABLE 14-30
WHITEOAK DAM AND RESERVOIR
PLAN B - WITH THE REFUGE
SUMMARY OF GENERAL RECREATION
AND FISH AND WILDLIFE INVESTMENT COSTS

	Item	Total
1.	General Recreation	
	Facilities	$ 9,887,400
	Contingencies	1,483,100
	Subtotal	$11,370,500
	E&D - S&A	2,062,000
	Total Facilities	$13,432,500
	Specific Recreation Land 1/	2,024,000
	Total Cost, Land & Facilities	$15,456,500
	Interest During Construction	1,004,700
	Total, General Recreation Investment	$16,461,200
2.	Fish and Wildlife	
	Apportioned Facilities 2/	$ 212,600
	Contingencies	31,900
	Subtotal	$ 244,500
	E&D - S&A	44,000
	Total Apportioned Facilities	$ 288,500
	Specific Fishery Facilities	$ 47,000
	Contingencies	7,000
	Subtotal	$ 54,000
	E&D - S&A	9,000
	Total Specific Facilities	$ 63,000
	Hunting Management Unit Facilities	$ 60,000
	Contingencies	9,000
	Subtotal	$ 69,000
	E&D - S&A	11,000
	Total Hunting Management Unit Facilities	$ 80,000
	Hunting Management Unit Land 1/	$ 1,458,500
	Total Cost F&WL Land & Facilities	$ 1,890,000
	Interest During Construction	122,800
	Total, Fish & Wildlife Investment	$ 2,012,800
3.	Inviolate Refuge	
	Facilities	$ 75,000
	Contingencies	11,000
	Subtotal	$ 86,000
	E&D - S&A	14,000
	Total Refuge Facilities	$ 100,000
	Inviolate Refuge Land 1/	1,458,500
	Total Cost Refuge Land & Facilities	$ 1,558,500
	Interest During Construction	101,300
	Total Refuge Investment	$ 1,659,800
	Total Recreation Investment Cost	$20,133,800

1/ Includes administrative costs and contingencies

2/ F&W shares some General Recreation facilities in proportion to user days: $\frac{\text{fishing \& hunting}}{\text{general recreation}} = \frac{20,000\ (\$10,100,000)}{950,000} = \$212,600$

For purposes of sub-allocation of costs, a proportionate share of those facilities to be used jointly by fishermen and hunters has been included under fish and wildlife facilities. The costs for basic fish and wildlife facilities are supplied by the U. S. Fish and Wildlife Service, Appendix G. To these were added the costs for specific refuge lands and a portion of facilities used jointly for both general recreation and fish and wildlife purposes. A summary of general recreation and fish and wildlife investment costs is given in Table 14-30.

The derivation of average annual costs for general and fish and wildlife recreation facilities is given in Table 14-31. Table 14-32 shows the derivation of alternative annual costs based on statistics from existing parks. The alternative annual costs are used for allocation purposes in Section VI.

TABLE 14-31
WHITEOAK DAM AND RESERVOIR
PLAN B - WITH THE REFUGE
ANNUAL COST DERIVATIONS
(General and fish and wildlife recreation)

OPERATION AND MAINTENANCE	
General recreation annual visitation (950,000 x 0.20)	$ 190,000
Fish and wildlife	15,500 1/
Total operation and maintenance	$ 205,500
INTEREST	
General recreation $16,461,200 x 0.0325	$ 535,000
Fish and wildlife 3,672,600 x 0.0325	119,400
Total interest	$ 654,400
AMORTIZATION	
General recreation $16,461,200 x 0.00138	$ 22,700
Fish and wildlife 3,672,600 x 0.00138	5,100
Total amortization	$ 27,800
MAJOR REPLACEMENTS	
General recreation $11,370,500 x 1/3 x 0.7424 x 0.03388	$ 95,300
Fish and wildlife 244,500 x 1/3 x 0.7424 x 0.03388	2,000
Total major replacements	$ 97,300
TOTAL AVERAGE ANNUAL COSTS (Financial)	$985,000

1/ Estimated by U. S. Fish and Wildlife Service (includes replacements of fish and wildlife and refuge facilities)

TABLE 14-32
WHITEOAK DAM AND RESERVOIR
PLAN B - WITH THE REFUGE
ALTERNATIVE ANNUAL COST DERIVATION FOR
GENERAL AND FISH AND WILDLIFE RECREATION

General recreation and fish and wildlife recreation outside refuge

Land acquired specifically for general recreation	3,100	
Hunting lands	2,750	
Joint use lands available to general recreation below refuge boundary (includes 747 Acre Recreation pool)	2,300	
Total	8,150	Acres

Annual attendance

General recreation	950,000
Fish and wildlife	20,060
Total	970,060

$\frac{970{,}060 \text{ (Annual attendance)}}{8{,}150 \text{ acres}}$ = 119 visitors/acre, density

Annual cost per visitor day = $ 0.74

Annual cost per visitor day escalated to July 1967 prices = .97

Total alternative annual economic cost
970,060 x $.97 — $941,000

Inviolate refuge — 202,100 1/

TOTAL ALTERNATIVE COST — $1,143,100

1/ Based on alternative first costs developed by U. S. Fish and Wildlife Service plus allowance for OM&R and loss of land economic productivity. First costs based on acquisition and development cost of Ottawa and Muscatatuck National Wildlife Refuges, Ohio and Indiana. See F&W report, Appendix G.

A comparison of land requirements for the two plans is given in Table 14-33.

TABLE 14-33
COMPARISON OF LAND REQUIREMENTS
PLAN A & PLAN B

Category	Plan A Without the Refuge	Plan B With the Refuge
	Acres	
Joint Use	4,900	4,900
General Recreation	4,950	3,100
Fish and Wildlife		
Refuge 1/	-	(5,500)
Other	-	-
Total fish and wildlife	0	5,500
Total lands	9,850	13,500

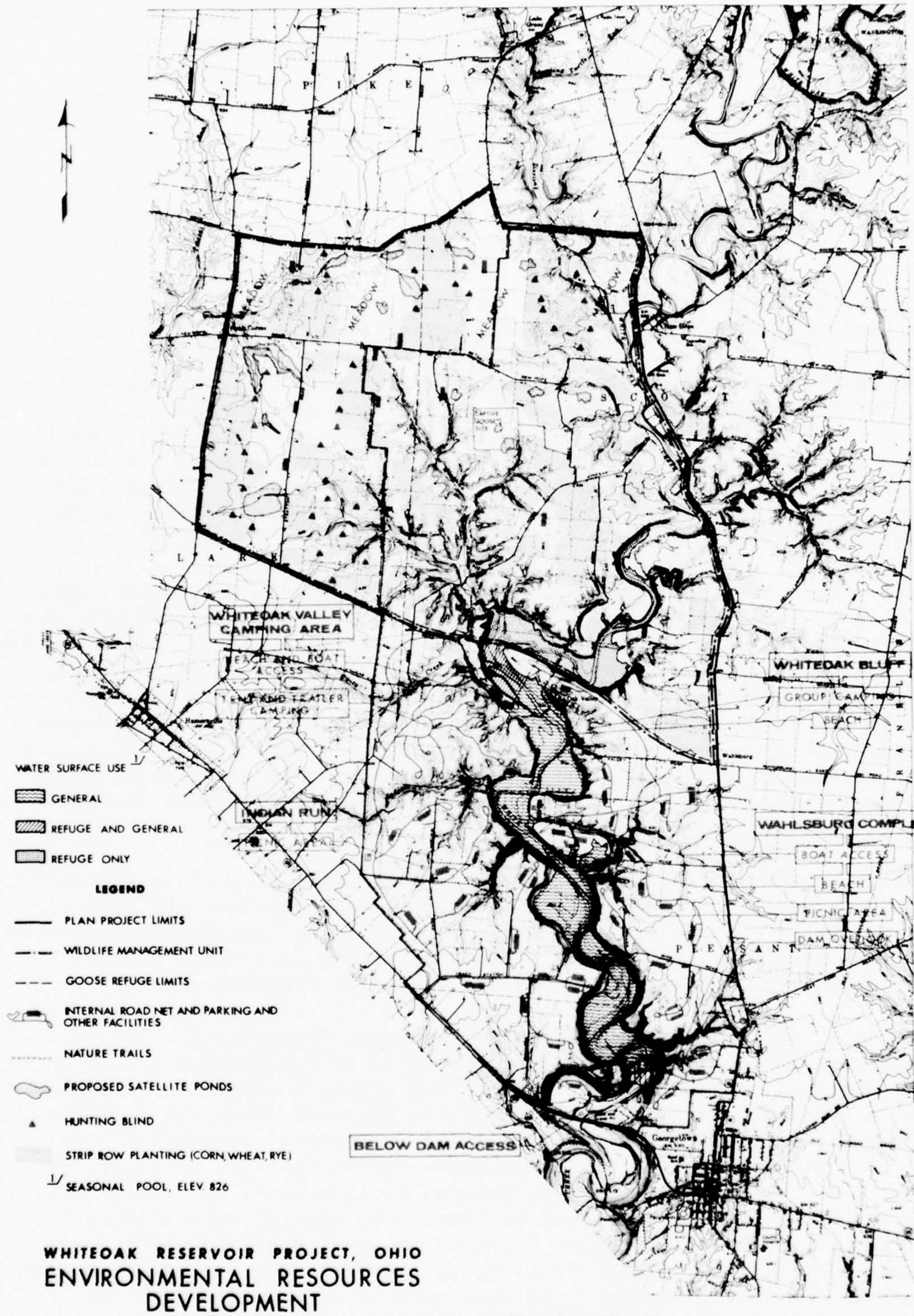
1/ Includes associated hunting lands adjacent to inviolate refuge. Does not include joint use lands of 2,000 acres within inviolate refuge.

The northern 184 acres of the seasonal pool would be within the refuge leaving 747 acres available for general recreation usage. Additionally, a 42 acre portion of the seasonal pool adjacent to the refuge boundary would be placed under joint general recreation and refuge management. Inclusion of the refuge reduces the recreation lake acreage by only 20 percent and the quantity of reasonable adjacent land by about 40 percent, thereby substantially decreasing the ratio of land acreage to lake surface acreage.

As a result of the decrease in recreation land acreage, facility development had to be scaled down; however, because of the high unsatisfied recreation demand in the zone of influence, the overall reduction in facilities was held to about 25 percent. Camping facilities were reduced proportionally more than other facilities because the more desirable land for camping is located in the confines of the refuge. It was also assumed that development of Plan B-With the Refuge would receive considerably more day-use than Plan A -Without the Refuge since the educational and scientific attributes of the plan would attract day visitors for nature study purposes during the goose migrating seasons.

The topography of the modified general recreation area is less adaptable to construction of access roads. Under these conditions the general recreation use of the project with the refuge would be roughly three-fourths that of Plan A-Without the Refuge. The proportional facilities costs, however, especially for circulatory roads, would be somewhat greater.

The Selected Plan for Environmental Resources Development. The plan of development for environmental resources would be established around a 931-acre seasonal pool at elevation 826. The northern portion of the project would be developed for fish and wildlife purposes while the southern sector would provide the area and facilities for general recreation uses. The selected plan would comprise three basic components: (1) an inviolate migratory goose refuge, (2) adjacent managed hunting lands and (3) a park-type development around the recreation lake. The general recreation portion of the plan also incorporates features to be used jointly by fishermen, especially in the tailwater area below the dam. The overall plan with the general locations of areas to be developed in conjunction with the proposed impoundment is shown on Exhibit 14-26.



WHITEOAK RESERVOIR PROJECT, OHIO

ENVIRONMENTAL RESOURCES DEVELOPMENT PLAN

U.S. ARMY ENGINEER DISTRICT HUNTINGTON & OHIO DEPARTMENT OF NATURAL RESOURCES

While the topography of the area is neither outstanding nor rugged, it does present a pleasant pastoral landscape, and with the formation of the reservoir creates a setting of substantially enhanced scenic quality. Existing wooded areas along the periphery of the pool will be supplemented and improved with planned reforestation. The proposed goose refuge will be of national significance, will greatly enhance sightseeing interest and will serve as a focal point, particularly during the seasons of the year when general recreation activities are not at a high intensity. The numerous arms and peninsulas created by the reservoir are advantageous to recreational development and every consideration is given to enhancing the individuals contact with the surrounding environment. Prominent knolls and small hills located throughout the project area provide exceptional panoramic views, including the dam and spillway and wide expanses of the lake. The two uses, refuge and general recreation, will be fitted together in such a way that each compliments the other and neither dominates the development. As indicated in the project development plan, the intensity of recreational development of the project has been kept to a minimum with facilities widely distributed throughout all the lands available.

The design density of the recreation facilities will be kept to a level which insures the maximum opportunity for the user to enjoy the resource. Camping areas will have four sites per acre with spacing between individual sites of approximately 120 feet, considerably greater than the normal spacing which ranges from 65-75 feet. At this spacing, 120 feet, each camp site will have allotted to it 10,890 square feet, including 3,500 square feet of road. Standard development of seven sites per acre provides 6,600 square feet per site of which 2,250 is in roadways.

The density of the facilities in the picnic area also will be four units per acre which provides a full 10,890 square feet per table.

The design criteria for swimming beaches is standard over much of the country, i.e. 50 square feet per person; however, an additional 2.5 acres of land per acre of dry beach will be provided for the necessary appurtenant bathing facilities.

In addition to the area required for parking, an acre of land will be provided for each two lane boat launching ramp. Parking spaces will be provided at the standard rate of 125 cars and 75 cars and trailers per acre. The total acreage of developed land has been increased by ten percent to provide for comfort stations, landscaping, game courts and the like.

A development of this intensity will accommodate, on the average, 17 persons per acre per instant, or a design load of 10,600 persons on 605 acres of developed land.

There are 1,100 acres of recreation land within the zone of water enhancement, excluding lands within the refuge and lands required for other project purposes. The proposed development therefore would require somewhat more than half this area, about 58 percent; 42 percent of the area would remain in scenic and aesthetic buffering.

Although such a water-oriented scheme would provide a quality development, it represents a type of development which is less resource-oriented than is considered desirable at this project. The same capacity, i.e. design load of 10,600, has been distributed throughout the entire area available for general recreational uses, i.e. 5,400 acres, with the result that on the average each acre will have to accommodate about two persons per instant, a condition not frequently found in the more extensive areas of state and national forest lands.

According to the Fish and Wildlife Service report in Appendix G, the reservoir would destroy about 760 man-days of stream fishing annually but the tailwater and impoundment fisheries created by the reservoir would amount to 14,320 man-days per year. Some public hunting presently is provided in the project area. The potential for upland game hunting is excellent in the cleared and cultivated portions of land to be acquired for the project. The Fish and Wildlife Service estimates that the losses in upland game hunting will be offset by provisions for upland game hunting on general recreation lands. Initially, land in the wildlife management unit will be closed to upland game hunting. Existing waterfowl hunting is negligible.

The wildlife management unit, comprised of 7,500 acres of land and encompassing approximately 184 acres of the seasonal pool, would be utilized entirely for the management, conservation and propagation of wildlife resources. Additionally, a 42-acre portion of the seasonal pool adjacent to the refuge boundary would be placed under joint general recreation and refuge management. This water area would be separated from the downstream area by a line of buoys to preclude boating. It would be accessible to the campers, and bank fishing would be permitted. A major portion of the management area (4,750 acres) would be designated as an inviolate goose refuge. The remaining acreage would provide area for intensive game management. Facilities would be provided to permit appropriate use of the area by the public.

Approximately 5,400 acres, or 40 percent of the total project lands, including 747 acres of the seasonal pool would be developed for optimum utilization by the public in pursuit of such major outdoor recreation

activities as boating, camping, swimming, fishing, picnicking, hiking, and sightseeing. Development to satisfy the public need will entail five separate areas, two of which are proposed as major day-use complexes, two others are for overnight camping, one of those being for group camping. The fifth area is downstream from the dam and would be for utilization of the tailwater fisheries. The plan, as shown on exhibit 14-26, represents the cooperative planning of the appropriate Federal agencies and the Ohio Department of Natural Resources. In view of expected heavy demands from the zone of influence, the plan of development has been prepared with a view to providing a high degree of quality in facility development for the betterment of the recreation experience. The character of facilities to implement the plan is based on criteria which generally exceeds those presently used by the Corps and the Ohio Department of Natural Resources. Prior discussions of development criteria has indicated that fewer facilities will be developed on each acre of ground, thus providing a more desirable recreation environment. The number of facilities is determined by criteria normally used by the Corps and as discussed with the Bureau of Outdoor Recreation and the Ohio Department of Natural Resources. Recreation usage projection estimates indicate that initial demands will exceed the optimum capacity of the park. The plan, therefore, envisions no future incremental development to accommodate long range growth in visitation at this time.

Existing Natural and Man-made Resources. The project area is characterized by an excellent potential for inclusion of the scenic and highly essential ecological resources into hiking and biological study programs, contingent upon their protection from disturbances during construction. The following guidelines cover items for particular emphasis:

Borrow areas, spoil areas, haul roads and clearing: Borrow for dam construction which cannot be removed from within the seasonal pool area and spillway cut will be scheduled for removal from other project land only after possible damage to project resources has been eliminated or minimized by integration of construction plans with the joint Corps of Engineers - Ohio Department of Natural Resources environmental resources development plan.

The location of all spoil areas and haul roads will be selected as with borrow areas with a view to later adaption into parking areas and access and circulation roads.

Access and haul roads for clearing purposes will be located in the same manner as construction haul roads. Buildings and other structure removal above seasonal pool elevation will be treated similarly with a view toward use in the development plan. No burning will be permitted above seasonal pool elevation.

Relocation of roads, utilities, and cemeteries: Road, electric transmission line, and cemetery relocation will be achieved to accommodate the plan for environmental resources development. Items for special emphasis are road alignment, borrow and spoil area location, and road construction criteria related to erosion control, landscaping, and visitor uses.

Abandonment of existing roads: All encumbrances on existing roads within the project boundary will be extinguished and the road right-of-way abandoned unless otherwise specified in the environmental resources development plan.

Historical, aesthetic, and scientific resources: The significance and disposition of existing resources in this categroy (which includes archeological, geological, and ecological features) will be determined more specifically during detailed post-authorization environmental resources planning. Important features will be marked for protection during project construction. The location of interpretive centers and nature trails described herein will be adjusted to include and highlight these features to supplement the outdoor recreation experience. The National Park Service will be notified when the project is authorized and will be afforded an opportunity to make a survey for archeological and historical features.

General Outdoor Recreation Activity Areas. This phase of the plan will feature controlled vehicular access using an entrance station on each side of the reservoir, and an interior stabilized-surface park road system of over 27 miles in length. The major development sites are on the relatively flat upland areas overlooking the river valley north of the dam, and extend as contiguous units on both sides to a point about 3-1/2 miles upstream from the dam to the south boundary of the wildlife management unit. The family and group camping areas provide a transition zone between the general recreation activities in the lower reservoir area and the wildlife-oriented recreation activities in and adjacent to the wildlife management unit in the upper reservoir area. Moreover, it is expected that the proximity of a managed "biological" area to these camping areas will serve as a special inducement for vacation camping at the reservoir.

General outdoor recreational activities will be concentrated in five distinct areas consisting of a high-density day-use area; a tent and trailer camping area; a medium-density day-use area: a group camping area; and a tailwater fishing area. Each of these areas will have individual water and sanitary systems to meet approved health standards. Access and circulation roads will have stabilized surface treatment. Landscaping in each area will take into account the ecological significance of the existing cover and topographical features and will be strategically planned for joint-use in scenic enhancement, activity separation, and soil stabilization. Management will be under the jurisdiction of the Ohio Department of Natural Resources.

Wahlsburg Complex - This 1,853-acre area extends along the entire left bank of the reservoir from the dam to the Whiteoak Bluff group camping complex. Near the upstream limits, its relatively steep shoreline grades into a gently-sloping peninsula on which a large swimming beach and a boat ramp and storage dock will be located. This area, which will be operated by the state, will also include picnicking and parking with capacities to compliment the beach and boating facilities. The remainder of the area will feature picnicking, nature hiking trails, and an overlook area with an interpretation center near the dam. The latter facility will provide a visitor-actuated audio-visual presentation of project history, historical and scientific features, and recreational guidance. The area is of sufficient size to provide the necessary flexibility of layout to accommodate the administrative requirements of the State Park program.

Whiteoak Valley Camping Complex - This wooded, moderately rolling area of 789 acres will feature tent and trailer camping. Supporting facilities include circulation roads, comfort station capacity to support the design load, an overlook and interpretation center, a launching ramp, and a camper swimming beach. The area is ideally located at the northern extremity of the Indian Run Picnic Area circulation road for good isolation, and adjacent to the south boundary of the refuge area, for enhancement of the camping experience through observation of migratory birds and associated aquatic plants and animals. Administrative facilities can be centrally located for efficient administration.

Indian Run Picnic Area - Development at this 1669-acre site on the lower right bank of the reservoir will feature a picnic area with parking, an overlook and interpretation center, and nature hiking trails. A steep shoreline will limit recreational development to the upland areas. A portion of the existing road system can be utilized for segments of the access and interior road system.

Whiteoak Bluff Group Camping Complex - This long narrow peninsular area of 161 acres is located across the reservoir from the family camping complex with ideal separation from day-use activities in the lower portion of the reservoir. Also, as with the family camping complex, this area is adjacent to the south boundary of the wildlife management unit providing unique nature study opportunities in addition to the usual outdoor group camping activities. The availability of the biological museum features of the wildlife management unit will make this area particularly attractive to organized youth groups, such as Boy and Girl Scouts, Future Farmers and Future Homemakers, and 4-H, as well as unorganized groups, such as neighborhood house, physically handicapped, and other community character-development programs.

Tailwater Fishing Area - An interpretation center, 84 picnic units, a trail to an overlook above the dam, and parking for 100 cars are planned for this 183-acre area. Water quality flexibility to be provided by a multi-level outlet will permit reasonable management of the downstream fishery to provide year-around warmwater fishing.

Wildlife Management Unit. As requested by the Ohio Department of Natural Resources and recommended in the Bureau of Sport Fisheries and Wildlife detailed fish and wildlife report of May 21, 1968, this management unit will function as a multiple-use area. However, goose and other species of waterfowl management and production will be emphasized.

The waterfowl and related management unit will be extensively developed. Included are: a forty-acre captive Canada goose breeding pen, fourteen satellite ponds, five nature trails, two observation mounds, thirteen parking lots, a manager's residence and service buildings. Based upon experience at other management areas, the proposed 7,900-acre wildlife management unit would be the minimum acreage required to properly manage and develop a waterfowl area. It was found on one other goose management area in northeastern Ohio (Mosquito Creek) that additional land was necessary to manage the increased number of waterfowl using the area. As a result, the State of Ohio recently purchased 5,500 acres of ground adjacent to Corps land where this project is located. The Whiteoak wildlife management unit should be expanded similarly by State acquisition, should forage needs for increased waterfowl use require it.

Large acreages of corn, wheat and other foods will be necessary to maintain an anticipated population of 10-15,000 resident and migratory geese, along with other species of waterfowl. The rate of grain consumption is approximately one-half pound of corn per day per goose. Therefore, approximately 7,500 pounds (125 bushels) of corn per day will be needed for a 15,000 goose-day use (15,000 geese on the area one day). Holding 15,000 geese for 90 calendar days maximum results in a total use of approximately 1,350,000 goose-days. The corn consumption would be approximately 675,000 pounds or 11,125 bushels. With an average corn yield of 80-90 bushels per acre, approximately 1,390 acres of corn land would be needed. Since the Division of Wildlife will share-crop, the goose management plan provides for cropping a minimum of 2,500-3,000 acres of corn.

There are only 25,000 acres of corn and 13,000 acres of soybeans produced annually in Brown County. Minimum yields and acreage limitations dictate the requirement for a large acreage on the management unit. However, this acreage is small compared with the 62,000 acres of corn and 54,000 acres of soybeans produced in Mercer County where the successful Mercer County Waterfowl Area is located.

As in Mercer County, farming will be done under cooperative agreements with neighboring farmers on the basis of soil tests, using agricultural procedures recommended by the Soil Conservation Service.

In order to establish local goose flight patterns essential for proper waterfowl harvest management, agricultural cropping patterns will contain a diversity of crops (corn, wheat, rye) in field layouts of long strips.

The development and required distribution of free nesting and local breeding populations of Canada geese will be achieved with the use of satellite ponds strategically located throughout the entire wildlife area. Ohio's program of "imprinting tub nesting" geese shows that geese can be induced to utilize any pond that is developed properly. Fourteen such ponds are planned for construction on and adjacent to the refuge.

Wide distribution of water areas is provided for goose resting areas within the refuge area along with creating flight patterns desired in the hunting zone.

It is anticipated that subsequent studies may indicate the need to develop one or two shallow impoundments by drilling wells such as those that are in operation at the Resthaven Wildlife Area in Huron County.

Thirteen hunter parking lots will be constructed within the hunting and refuge zones. Hunters will drive to the parking lot nearest their shooting zone rather than being distributed by the area manager.

Five nature trails will be developed initially in the refuge zone for bird watching, hiking, photographic endeavors, and general observation. Parking lots for hunting also will be utilized in conjunction with nature trails in the refuge portion.

Two observation towers will be constructed in the area. Heavy use by the public is anticipated, based on experience at the tower located on Killdeer Wildlife Area in central Ohio, and in other states. A study of the Horicon Marsh in Wisconsin revealed that 41,500 persons in 1960 and 75,800 in 1961 came expressly to watch and observe the geese. Reports from Michigan reveal that 250,000 people visited the Kellogg Bird Sanctuary near Battle Creek and Kalamazoo.

The management unit also lends itself and is expected to support use as a research center for agricultural practices, horticultural techniques, and wildlife pathological studies in conjunction with local university and college academic and extension programs of wildlife management. Visitation by elementary school children will be accommodated not only for nature study field trips, but for demonstrations of soil, water and wildlife conservation practices.

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SECTION IV - COST ESTIMATES

15. PROJECT COST

The capital cost as used in this section consists of the initial costs for such project items as lands and damages, relocations, dam and appurtenant works, facilities for recreation, fish and wildlife development including the refuge, engineering and design, and supervision and administration. All capital costs are usually referred to as construction costs and exclude interest incurred during construction. Construction costs were based upon detailed layouts shown on Exhibits 14-23 and 14-24 and design considerations discussed in Section III. Unit prices for the estimates are based upon costs for similar work performed in nearby areas and upon prices prevailing in July 1967. Table 14-34 summarizes the costs for the proposed Whiteoak Dam and Reservoir for Plan A - Without the Refuge. Detailed estimates of capital costs are shown in Table 14-35. The costs for Whiteoak Dam and Reservoir Plan B - With the Refuge are summarized in Table 14-36. Detailed estimates are included in Table 14-37. The total cost of construction of the recommended water project with the refuge is estimated to be $40,031,000.

Investment costs are the sum of the capital costs and the accrued interests on those expenditures up to the time the project services become available. Interest during construction on capital costs was computed by multiplying the construction expenditure by an interest rate of 3.25 percent for one-half the construction period in years. The construction period for Whiteoak Dam and Reservoir was assumed to be four years.

Investment costs, adjustments for changes in land productivity rates, and costs of operation, maintenance and major replacement must be reduced to a common time basis, corresponding to benefit computations, for the purposes of the project evaluation, comparison of alternative projects, and for cost allocation. The investment costs were reduced to their annual equivalent by considering the interest on, and the amortization of, the initial investment at an interest rate of 3.25 percent per annum over an amortization period of 100 years. Operation and maintenance charges for the proposed development are based upon current costs at similar projects and include cost for major replacement items as applicable. The sum of these items gives the total annual costs, either financial or economic. The total annual economic cost differs from the annual financial cost in that it reflects the adjustment for net loss of economic productivity of land. All lands required for the project were considered to have a present rate of productivity equal to five percent of their value annually. When these lands are converted to project use, they are considered to have a productivity equal to the risk free Government interest rate applicable at the time the cost estimate was prepared.

The difference in the annual productivity rates multiplied by the value of the lands is equal to the net annual loss of production to the economy. Detailed estimates of annual financial and economic costs of the water project without and with the refuge are included in Tables 14-38 and 14-39, respectively.

TABLE 14-34
SUMMARY OF COSTS
PLAN A - WITHOUT THE REFUGE
WHITEOAK DAM AND RESERVOIR

(Based on prices prevailing in July 1967)

No.	Item	Cost	Cost with Items Nos. 7 and 8 distributed
1.	Lands and damages 1/	$ 5,102,000	$ 5,102,000
2.	Relocations	2,650,000	3,119,000
3.	Reservoir	332,000	390,000
4.	Dam and appurtenances	13,400,000	15,770,000
5.	Recreation	15,550,000	18,301,000
6.	Permanent operating equipment	185,000	218,000
7.	Engineering and design	3,115,000	-
8.	Supervision and administration	2,566,000	-
	Total cost 2/	$ 42,900,000	$ 42,900,000

1/ Includes $2,883,200 specifically for general recreation.
2/ Does not include $60,000 for preauthorization studies.

TABLE 14-35
DETAILED ESTIMATE OF CAPITAL COST
PLAN A - WITHOUT THE REFUGE
WHITLOAK DAM AND RESERVOIR
(Based on prices prevailing in July 1967)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES				
Fee acquisition				
Improved residential sites	Acre	17	$2,000	$ 34,000
Commercial church sites	Acre	20	1,500	30,000
Potential frontage sites	Acre	48	1,350	64,800
Rural homesites	Acre	200	860	172,000
Croplands	Acre	5,650	270	1,525,500
Pasture	Acre	2,170	125	271,250
Woodlands	Acre	1,530	70	107,100
Creek beds & ravines	Acre	665	25	16,625
Subtotal, land		10,300		$2,221,275
Improvements				
Farm buildings	Sets	153	-	$1,449,675
Commercial	Sets	3	-	51,000
Churches	Sets	3	-	72,000
Subtotal, improvements		159		$1,572,675
Severance damages	L.S.	-	-	65,000
Subtotal, fee lands and damages				$3,858,950
Contingencies				964,650
Total fee acquisition				$4,823,600
Resettlement costs	Tracts	150	$ 400	60,000
Administrative costs	Tracts	182	1,200	218,400
TOTAL, LANDS AND DAMAGES				$5,102,000

TABLE 14-35 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
RELOCATIONS				
Roads				
U.S. 68 (relocate)	Mile	1.7	-	$ 525,000
Brown Co. 5 (relocate & new bridge)	Mile	0.8	-	220,000
Brown Co. 21 (relocate)	Mile	2.3	-	288,000
Brown Co. 83 (relocate)	Mile	2.2	-	310,000
Subtotal, Roads		7.0		$1,343,000
Utilities				
Power lines (relocate)	L.S.	-	-	650,000
Telephone lines (relocate)	Mile	13.0	-	50,000
Subtotal, Utilities				$ 700,000
Cemeteries (8)				
Graves	Ea.	400	$ 300	$ 120,000
Beautification	L.S.	-	-	$ 47,000
Subtotal, Relocations				$2,210,000
Contingencies				440,000
TOTAL, RELOCATIONS				$2,650,000
RESERVOIR				
Clearing reservoir	Acre	360	250	$ 90,000
Clearing reservoir (for W.S.)	Acre	619	250	154,750
Boundary marking	Mile	16	2,000	32,000
Subtotal, Reservoir				$ 276,750
Contingencies				55,250
TOTAL, RESERVOIR				$ 332,000

TABLE 14-35 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES				
Dam and Spillway				
Care & diversion of water	L.S.	1	$ -	$ 75,000
Field office building	L.S.	1	-	50,000
Clearing and grubbing	Acre	72	350.00	25,200
Excavation				
Common	C.Y.	717,000	.90	645,300
Rock	C.Y.	272,000	1.75	476,000
Spillway weir and walls	C.Y.	2,610	10.00	26,100
Borrow	C.Y.	4,950,000	.75	3,712,500
Embankment				
Impervious	C.Y.	4,150,000	.20	830,000
Random	C.Y.	299,000	.20	59,800
Backfill	C.Y.	36,000	.10	3,600
Inclined and blanket drains	C.Y.	112,000	6.00	672,000
Riprap	C.Y.	72,100	7.00	504,700
Bedding material	C.Y.	24,000	3.00	72,000
Foundation drilling for grouting	L.F.	19,200	3.00	57,600
Foundation grouting	Bags	14,400	4.50	64,800
Rock paved gutter	L.F.	4,000	5.00	20,000
Anchor bars, grouted in place	L.F.	4,000	3.00	12,000
Drain holes, 3"	L.F.	1,000	4.00	4,000
Concrete, spillway weir and walls	C.Y.	2,610	40.00	104,400
Cement	Bbl.	3,200	5.50	17,600
Steel reinforcement	Lb.	310,000	.17	52,700
Road surfacing across dam	Sq.Yd.	5,200	10.00	52,000
Guard rail	L.F.	3,800	4.00	15,200
Seeding and top soil	Acres	12	550.00	6,600
Subtotal, Dam and Spillway				$7,559,100

TABLE 14-35 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Outlet Works				
Clearing & grubbing	Acre	6	$ 450.00	$ 2,700
Excavation				
Earth	C.Y.	10,000	1.50	15,000
Rock	C.Y.	57,600	2.50	144,000
Tunnel	C.Y.	13,000	25.00	325,000
Rock surface treatment	Sq.	260	40.00	10,400
Riprap	C.Y.	400	7.00	2,800
Blanket drain material	C.Y.	250	6.00	1,500
Tunnel grouting	L.S.	1	-	50,000
Rock bolting portal face	Lb.	5,600	1.50	8,400
Steel tunnel supports	Lb.	1,000,000	.22	220,000
Anchor bars, grouted in place	L.F.	3,300	3.00	9,900
Drain holes, 3"	L.F.	1,100	4.00	4,400
Concrete				
Intake Structure	C.Y.	7,800	70.00	546,000
Tunnel & transition	C.Y.	6,600	55.00	363,000
Stilling basin slab and keys	C.Y.	1,060	40.00	42,400
Stilling basin liner walls	C.Y.	960	55.00	52,800
Cement	Bbl.	24,600	5.50	135,300
Steel reinforcement	Lb.	1,500,000	.17	255,000
Waterstops, rubber	L.F.	800	5.00	4,000
Waterstops, W.I.	L.F.	2,000	3.20	6,400
Superstructure, intake structure	L.S.	1	-	100,000
5'-8" x 10'-0" slide gates and liners	L.S.	2	-	350,000
4' x 3' Hydraulically operated sluice gates	Each	2	4,600.00	9,200
30" Hydraulically operated gate valve	Each	1	10,300.00	10,300
Slide gate hydraulic system	L.S.	1	-	32,000
Low flow trash racks and bulkheads and guides	L.S.	1	-	11,500
Emergency bulkhead frames and guides	L.S.	1	-	60,000
Pickup beam	Each	1	7,000.00	7,000
Traveling crane, 20 T	Each	1	46,000.00	46,000
Float well assembly	L.S.	1	-	10,500
Air vent system	L.S.	1	-	15,000
Water supply system	L.S.	1	-	17,200
Plumbing and drainage	L.S.	1	-	5,700

TABLE 14-35 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Outlet Works (cont'd)				
Sump pump	L.S.	1	$ -	$ 1,700
Heating and ventilating	L.S.	1	-	11,500
Electrical work	L.S.	1	-	60,000
Standby electric generator set	Ea.	1	15,000.00	15,000
Elevator and shaft framing	L.S.	1	-	40,000
Tile gage	L.S.	1	-	3,000
Spiral stairway	L.S.	1	-	4,600
Miscellaneous ferrous metals	L.S.	1	-	17,200
Miscellaneous non ferrous metals	L.S.	1	-	11,500
Trash guards	L.S.	1	-	23,000
Service bridge	L.S.	1	-	28,800
Bulkhead door	L.S.	1	-	1,200
Handrail	L.F.	400	7.50	3,000
Seeding	Acres	4	500.00	2,000
Gaging station	L.S.	1	-	50,000
	Subtotal, Outlet Works			$3,145,900
Access Road				
Clearing and grubbing	Acre	4	$550.00	$ 2,200
Grading	Sta.	21	3,500.00	73,500
Surfacing	Sq.Yd.	5,000	13.00	65,000
Drainage structures	L.S.	1	-	6,900
Guard rail	L.F.	2,100	4.00	8,400
Seeding	Acre	2	450.00	900
Speed-change lane	Sq.Yd.	700	15.00	10,500
	Subtotal, Access Road			$167,400
Beautification				260,000
Subtotal				11,132,400
Contingencies				2,267,600
TOTAL, DAM AND APPURTENANCES				$13,400,000

TABLE 14-35 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
RECREATION 1/				
General recreation facilities				$13,000,000
Contingencies				1,950,000
Subtotal, General recreation				14,950,000
Fish and wildlife facilities				520,000
Contingencies				80,000
Subtotal, fish and wildlife				600,000
TOTAL, RECREATION 1/				$15,550,000

1/ Does not include cost for Lands and Damages. See page III-14-127 for a detailed estimate.

Item	Unit	Quantity	Unit Price	Amount
PERMANENT OPERATION EQUIPMENT				
Operating quarters	Ea.	2	$15,000	$ 30,000
Tractor, truck, boat, mower, tools, etc.	Lot	1	-	15,000
Utility building	Job	1	-	7,000
Rainfall and discharging stations				
Inflow station	Job	1	-	20,000
Lake gage (intake struct.)	Job	1	-	4,000
Equipment for discharging station at dam	Job	1	-	2,000
Outflow station (downstream)	Job	1	-	20,000
Equipment for W.Q.C.	Job	1	-	10,000
Rainfall gages	Ea.	4	350	1,400
Radio facilities	Job	1	-	25,000
Beautification (oper. qtrs.)	Job	1	-	20,000
Subtotal				$ 154,400
Contingencies				30,600
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 185,000
ENGINEERING AND DESIGN				
Initial development	L.S.	-	-	$ 3,115,000
Future increment	L.S.	-	-	0
TOTAL, ENGINEERING AND DESIGN				$ 3,115,000
SUPERVISION AND ADMINISTRATION				
Initial development	L.S.	-	-	$ 2,566,000
Future increment	L.S.	-	-	0
TOTAL, SUPERVISION AND ADMINISTRATION				$ 2,566,000

TABLE 14-35 (Cont'd)
DETAILED ESTIMATE OF GENERAL RECREATION
FISH AND WILDLIFE ENHANCEMENT - PLAN A - WITHOUT THE REFUGE
WHITEOAK DAM AND RESERVOIR

Item	Unit	Quantity	Unit Cost	Amount
FACILITIES				
Roads (Asphalt & chip & seal)	Mile	37	$ 85,000	$ 3,145,000
Picnic Units	Each	2340	500	1,270,000
Picnic Shelters	Each	15	15,000	225,000
Camping Units	Each	800	500	400,000
Parking Spaces (Asphalt & chip & seal)	Each	3100	400	1,240,000
Launching Ramps & Stanchions	12'lanes	12	5,000	60,000
Water supply facilities 1/	Job	1	1,750,000	1,750,000
Sanitary facilities 2/	Job	1	1,534,000	1,534,000
Beach development	Job	4	550,000	2,200,000
Trails	Mile	10	7,800	78,000
Landscaping	Acre	4900	250	1,225,000
Utilities	Job	1	202,500	202,000
Signs	Job	1	25,000	25,000
Interpretive Center	Each	1	150,000	150,000
Incinerator	Each	4	4,000	16,000
Subtotal, facilities				$13,520,000
Contingencies				2,030,000
Total				$15,550,000

1/ Includes treatment & distribution system.
2/ Includes restrooms, showerhouses, washhouses and collection and treatment system.

TABLE 14-36

SUMMARY OF COSTS
PLAN B - WITH THE REFUGE
WHITEOAK DAM AND RESERVOIR
(Based on prices prevailing in July 1967)

No.	Item	Cost	Cost with Items Nos. 7 and 8 distributed
1.	Lands and damages 1/	$ 7,229,000	$ 7,229,000
2.	Relocations	2,030,000	2,398,000
3.	Reservoir	332,000	392,000
4.	Dam and appurtenances	13,400,000	15,830,000
5.	Recreation	11,824,000	13,964,000
	General Recreation	(11,370,500)	(13,432,500)
	Fish and Wildlife	(367,500)	(431,500)
	Inviolate Refuge	(86,000)	(100,000)
6.	Permanent operating equipment	185,000	218,000
7.	Engineering and design	2,776,000	-
8.	Supervision and administration	2,255,000	-
	Total cost 2/	$40,031,000	$40,031,000

1/ Includes $2,024,000 specifically for general recreation and $2,917,000 specifically for refuge and management area

2/ Does not include $60,000 for preauthorization studies

TABLE 14-37
DETAILED ESTIMATE OF CAPITAL COST
PLAN B - WITH THE REFUGE
WHITEOAK DAM AND RESERVOIR
(Based on prices prevailing in July 1967)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES				
Joint Use Lands				
Fee Acquisition				
Improved residential sites	Acre	19	$2,000	$ 38,000
Commercial church sites	Acre	15	2,000	30,000
Potential frontage sites	Acre	5	1,400	7,000
Rural home sites	Acre	84	900	75,600
Croplands	Acre	2,650	270	715,500
Tobacco base	Acre	30	350	10,500
Pasture	Acre	1,125	130	146,250
Woodlands	Acre	800	70	56,000
Creek banks and ravines	Acre	172	25	4,300
Subtotal, land		4,900		$1,083,150
Improvements				
Farm buildings	Sets	54	-	$ 546,000
Commercial	Sets	2	-	40,000
Churches	Sets	2	-	28,000
Subtotal, improvements		58		$ 614,000
Severance damages	L.S.	-	-	$ 23,000
Subtotal, fee lands and damages				$1,720,150
Contingencies				429,850
Total, fee acquisition				$2,150,000
Resettlement costs	Tracts	75	$ 400	$ 30,000
Administrative costs	Tracts	90	$1,200	$ 108,000
Total, Joint Use Lands				$2,288,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Specific Recreation Lands				
Fee Acquisition				
Improved residential sites	Acre	18	$2,000	$ 36,000
Commercial church sites	Acre	6	2,000	12,000
Potential frontage sites	Acre	100	1,400	140,000
Rural home sites	Acre	80	900	72,000
Croplands	Acre	1,700	270	459,000
Tobacco base	Acre	30	350	10,500
Pasture	Acre	600	130	78,000
Woodlands	Acre	400	70	26,500
Creek banks and ravines	Acre	166	25	4,150
Subtotal, land		3,100		$ 838,150
Improvements				
Farm buildings	Sets	65	-	$ 695,500
Commercial	Sets	2	-	22,000
Subtotal, improvements		67		$ 717,500
Severance damages	L.S.	-	-	$ 7,500
Subtotal, fee lands and damages				$1,563,150
Contingencies				390,850
Total, fee acquisition				$1,954,000
Resettlement costs	Tracts	-	-	$ 34,000
Administrative costs	Tracts	30	1,200	$ 36,000
Total, Specific Recreation Lands				$2,024,000
Specific Refuge Lands				
Fee Acquisition				
Improved residential sites	Acre	28	$2,000	$ 56,000
Commercial church sites	Acre	2	2,000	4,000
Potential frontage sites	Acre	10	1,400	14,000
Rural home sites	Acre	160	900	144,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Croplands	Acre	3,000	$ 270	$ 810,000
Tobacco base	Acre	40	350	14,000
Pasture	Acre	1,000	130	143,000
Woodlands	Acre	600	70	42,000
Creek banks and ravines	Acre	560	25	14,000
Subtotal, land		5,500		$1,241,000
Improvements				
Farm buildings	Sets	105	-	$ 970,000
Commercial	Sets	1	-	5,000
Subtotal, improvements		106		$ 975,000
Severance damages	L.S.	-	-	$ 8,000
Subtotal, fee lands and damages				$2,224,000
Contingencies				556,000
Total, fee acquisition				$2,780,000
Resettlement costs	Tracts	-	-	$ 53,000
Administrative costs	Tracts	70	-	$ 84,000
Total, Specific Refuge Lands				$2,917,000
TOTAL, LANDS AND DAMAGES				$7,229,000
RELOCATIONS				
Roads				
U. S. 68 (relocate)	Mile	1.7	-	$ 525,000
Brown Co. 21 (relocate)	Mile	2.3	-	288,000
Subtotal, Roads		4.0		$ 813,000
Utilities				
Power lines	L.S.	-	-	$ 686,000
Telephone lines	L.S.	-	-	45,000
Subtotal, Utilities				$ 731,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Cemeteries (8)				
Graves	Ea.	400	$ 300.00	$ 120,000
Beautification	L.S.	-	-	30,000
Subtotal, Relocations				$1,694,000
Contingencies				336,000
TOTAL, RELOCATIONS				$2,030,000
RESERVOIR				
Clearing reservoir	Acre	360	$ 250.00	$ 90,000
Clearing reservoir (for W.S.)	Acre	619	250.00	154,750
Boundary marking	Mile	16	2,000.00	32,000
Subtotal, Reservoir				$ 276,750
Contingencies				55,250
TOTAL, RESERVOIR				$ 332,000
DAM AND APPURTENANCES				
Dam and Spillway				
Care and diversion of water	L.S.	1	$ -	$ 75,000
Field office building	L.S.	1	-	50,000
Clearing and grubbing	Acre	72	350.00	25,200
Excavation				
Common	C.Y.	717,000	.90	645,300
Rock	C.Y.	272,000	1.75	476,000
Spillway weir and walls	C.Y.	2,610	10.00	26,100
Borrow	C.Y.	4,950,000	.75	3,712,500
Embankment				
Impervious	C.Y.	4,150,000	.20	830,000
Random	C.Y.	299,000	.20	59,800
Backfill	C.Y.	36,000	.10	3,600
Inclined and blanket drains	C.Y.	112,000	6.00	672,000
Riprap	C.Y.	72,100	7.00	504,700
Bedding material	C.Y.	24,000	3.00	72,000
Foundation drilling for grouting	L.F.	19,200	3.00	57,600
Foundation grouting	Bags	14,400	4.50	64,800

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Rock paved gutter	L.F.	4,000	$ 5.00	$ 20,000
Anchor bars, grouted in place	L.F.	4,000	3.00	12,000
Drain holes, 3"	L.F.	1,000	4.00	4,000
Concrete, spillway weir and walls	C.Y.	2,610	40.00	104,400
Cement	Bbl.	3,200	5.50	17,600
Steel reinforcement	Lb.	310,000	.17	52,700
Road surfacing across dam	Sq.Yd.	5,200	10.00	52,000
Guard rail	L.F.	3,800	4.00	15,200
Seeding and top soil	Acre	12	550.00	6,600
Subtotal, Dam and Spillway				$7,559,100
Outlet Works				
Clearing and grubbing	Acre	6	$ 450.00	$ 2,700
Excavation				
Earth	C.Y.	10,000	1.50	15,000
Rock	C.Y.	57,600	2.50	144,000
Tunnel	C.Y.	13,000	25.00	325,000
Rock surface treatment	Sq.	260	40.00	10,400
Riprap	C.Y.	400	7.00	2,800
Blanket drain material	C.Y.	250	6.00	1,500
Tunnel grouting	L.S.	1	-	50,000
Rock bolting portal face	Lb.	5,600	1.50	8,400
Steel tunnel supports	Lb.	1,000,000	.22	220,000
Anchor bars, grouted in place	L.F.	3,300	3.00	9,900
Drain holes, 3"	L.F.	1,100	4.00	4,400
Concrete				
Intake structure	C.Y.	7,800	70.00	546,000
Tunnel and transition	C.Y.	6,600	55.00	363,000
Stilling basin slab and keys	C.Y.	1,060	40.00	42,400
Stilling basin liner walls	C.Y.	960	55.00	52,800
Cement	Bbl.	24,600	5.50	135,300
Steel reinforcement	Lb.	1,500,000	.17	255,000
Waterstops, rubber	L.F.	800	5.00	4,000
Waterstops, W.I.	L.F.	2,000	3.20	6,400
Superstructure, intake structure	L.S.	1	-	100,000
5'-8" x 10'-0" slide gates and liners	L.S.	2	-	350,000
4' x 3' Hydraulically operated sluice gates	Ea.	2	4,600.00	9,200
30" Hydraulically operated gate valve	Ea.	1	10,300.00	10,300
Slide gate hydraulic system	L.S.	1	-	32,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Low flow trash racks and bulkheads and guides	L.S.	1	$ -	$ 11,500
Emergency bulknead frames and guides	L.S.	1	-	60,000
Pickup beam	Ea.	1	7,000.00	7,000
Traveling crane, 20 T	Ea.	1	46,000.00	46,000
Float well assembly	L.S.	1	-	10,500
Air vent system	L.S.	1	-	15,000
Water supply system	L.S.	1	-	17,200
Plumbing and drainage	L.S.	1	-	5,700
Sump pump	L.S.	1	-	1,700
Heating and ventilating	L.S.	1	-	11,500
Electrical work	L.S.	1	-	60,000
Standby electric generator set	Ea.	1	15,000.00	15,000
Elevator and shaft framing	L.S.	1	-	40,000
Tile gage	L.S.	1	-	3,000
Spiral stairway	L.S.	1	-	4,600
Miscellaneous ferrous metals	L.S.	1	-	17,200
Miscellaneous non ferrous metals	L.S.	1	-	11,500
Trash guards	L.S.	1	-	23,000
Service bridge	L.S.	1	-	28,800
Bulknead door	L.S.	1	-	1,200
Handrail	L.F.	400	7.50	3,000
Seeding	Acre	4	500.00	2,000
Gaging station	L.S.	1	-	50,000
Subtotal, Outlet Works				$3,145,900
Access Road				
Clearing and grubbing	Acre	4	$ 550.00	$ 2,200
Grading	Sta.	21	3,500.00	73,500
Surfacing	Sq.Yd.	5,000	13.00	65,000
Drainage structures	L.S.	1	-	6,900
Guard rail	L.F.	2,100	4.00	8,400
Seeding	Acre	2	450.00	900
Speed-change lane	Sq.Yd.	700	15.00	10,500
Subtotal, Access Road				$ 167,400
Beautification				$ 260,000
Subtotal				$11,132,400
Contingencies				$ 2,267,600
TOTAL, DAM AND APPURTENANCES				$13,400,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
RECREATION 1/				
General recreation facilities				$ 9,887,400
Contingencies				1,483,100
Subtotal General recreation				$11,370,500
Fish and wildlife facilities				$ 455,600
Contingencies				31,900
Subtotal, Fish and wildlife				$ 487,500
TOTAL, RECREATION 1/				$11,858,000

1/ Does not include cost for Lands and Damages. See Table 14-40 for detailed estimate.

Item	Unit	Quantity	Unit Price	Amount
PERMANENT OPERATING EQUIPMENT				
Operating quarters	Ea.	2	$15,000.00	$ 30,000
Tractor, truck, boat, mower, tools, etc.	Lot	1	-	15,000
Utility building	Job	1	-	7,000
Rainfall and discharging stations				
Inflow station	Job	1	-	20,000
Lake gage (intake structure)	Job	1	-	4,000
Equipment for discharging station at dam	Job	1	-	2,000
Outflow station (downstream)	Job	1	-	20,000
Equipment for W.Q.C.	Job	1	-	10,000
Rainfall gages	Ea.	4	350.000	1,400
Radio facilities	Job	1	-	25,000
Beautification (oper. qtrs.)	Job	1	-	20,000
Subtotal				$ 154,400
Contingencies				30,600
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 185,000

TABLE 14-37 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
ENGINEERING AND DESIGN				
Initial development	L.S.	-	-	$ 2,776,000
Future increment	L.S.	-	-	0
TOTAL, ENGINEERING AND DESIGN				$ 2,776,000
SUPERVISION AND ADMINISTRATION				
Initial development	L.S.	-	-	$ 2,255,000
Future increment	L.S.	-	-	0
TOTAL, SUPERVISION AND ADMINISTRATION				$ 2,255,000

TABLE 14-38

DETAILED ESTIMATE OF ANNUAL COST
PLAN A - WITHOUT THE REFUGE
WHITEOAK DAM AND RESERVOIR

Item	Financial Costs	Economic Costs
a. Total investment		
(1) Recapitulation of project costs		
(a) Initial costs	$ 42,900,000	$42,900,000
(b) Incremental costs	-	-
(c) Market value of lands	-	(2,777,000)
(2) Interest during construction (initial costs only) at 3-1/4% for 1/2 of construction period of 4 years	2,788,500	2,788.500
(3) Total gross investment	$ 45,688,500	$45,688,500
b. Annual initial costs		
(1) Interest on gross investment		
(a) Recreation	$ 733,200	$ 733,200
(b) Remaining costs (23,127,300) (0.0325)	751,600	751,600
(c) Adjustment for net loss of land (5%-3-1/4%)(2,777,000)	-	(48,600)
(2) Amortization		
(a) Recreation	31,100	31,100
(b) Remaining costs (23,127,300)(0.00138)	31,900	31,900
(3) Maintenance and operation		
(a) Dam and reservoir	50,000	50,000
(b) Water quality control & water supply	5,000	5,000
(c) Recreation	275,200	275,200
(4) Major replacements		
(a) Dam and reservoir	2,000	2,000
(b) Water quality control & water supply	200	200
(c) Recreation	130,400	130,400
(5) Total annual initial costs	$2,010,600	$2,059,200
c. Annual future recreation incremental costs	0	0
d. Total annual costs	$2,010,600	$2,059,200

TABLE 14-39
DETAILED ESTIMATE OF ANNUAL COST
PLAN B - WITH THE REFUGE
WHITEOAK DAM AND RESERVOIR

Item	Financial Costs	Economic Costs
a. Total investment		
(1) Recapitulation of project costs		
(a) Initial costs	$40,031,000	$40,031,000
(b) Incremental costs	-	-
(c) Market value of lands	-	(3,952,900)
(2) Interest during construction (initial costs only) at 3-1/4% for 1/2 of construction period of 4 years	2,602,000	2,602,000
(3) Total gross investment	$42,633,000	$42,633,000
b. Annual initial costs		
(1) Interest on gross investment		
(a) Recreation	$ 654,400	$ 654,400
(b) Remaining costs (22,499,200) (0.0325)	731,200	731,200
(c) Adjustment for net loss of land (5%-3-1/4%) (3,952,000)	-	69,200
(2) Amortization		
(a) Recreation	$ 27,800	$ 27,800
(b) Remaining costs (22,499,200)(0.00138)	31,100	31,100
(2) Maintenance and operation		
(a) Dam and reservoir	$ 50,000	$ 50,000
(b) Water quality control and water supply	5,000	5,000
(c) Recreation	205,500	205,500
(4) Major replacements		
(a) Dam and reservoir	$ 2,000	$ 2,000
(b) Water quality control and water supply	200	200
(c) Recreation	97,300	97,300
(5) Total annual initial costs	$ 1,804,500	$ 1,873,700
c. Annual future recreation incremental costs	0	0
d. Total annual costs	$ 1,804,500	$ 1,873,700

Costs for General Recreation and Fish and Wildlife Enhancement Features of the Recommended Plan. The recommended plan of development for general recreation with the refuge envisions a well developed complement of facilities to best suit the character of the primarily day-use project. Facility sizing was based on design load factors derived from compilation of data from similar existing developments as discussed previously in Section III of this chapter. The amount of lands which would be acquired specifically for general recreation exceeds the quantity suggested by the Bureau of Outdoor Recreation partly because of the large size of tracts involved and partly to provide a peripheral buffer to maintain the aesthetic integrity of the project.

Table 14-40 summarizes the general recreation, fish and wildlife enhancement and inviolate refuge costs for the formulated plan. Since it is anticipated that the initial demands on this project will exceed the optimum capacity for utilization, the entire public-use development should be available when the project first becomes operative. The plan of development thus envisions no future incremental development.

The costs for basic fish and wildlife facilities were extracted from the report of the U. S. Fish and Wildlife Service. To these were added the costs for specific refuge lands and for a proportionate share of facilities used jointly for both general recreation and fish and wildlife purposes.

The annual cost of operation and maintenance of the recreational facilities has been based on an analysis of the reservoir management organization required for the estimated attendance; the various items of maintenance equipment required and their useful life; and the roads to be maintained for recreation. The cost of replacement of recreation facilities and roads also was determined based on one-third of the facilities being replaced every 25 years over the 100-year economic life of the project. The operation and maintenance costs for the formulated plan are presented in Table 14-41, which contains a detailed summary of construction and investment costs and annual charges for general recreation and fish and wildlife developments including the refuge at Whiteoak Reservoir.

TABLE 14-40

DETAILED ESTIMATE OF GENERAL RECREATION
FISH AND WILDLIFE ENHANCEMENT AND INVIOLATE REFUGE COSTS
THE SELECTED PLAN OF DEVELOPMENT - WHITEOAK DAM AND RESERVOIR

Item	Unit	Quantity	Unit Cost	Amount
FACILITIES				
Roads (Asphalt & chip & seal)	Mile	29.6	$ 85,000	$ 2,500,000
Picnic Units	Each	1640	500	820,000
Picnic Shelters	Each	10	15,000	150,000
Camping Units	Each	400	500	200,000
Parking Spaces (Asphalt & chip & seal)	Each	2675	400	1,070,000
Launching Ramps & Stanchions	12' lanes	8	5,000	40,000
Water supply facilities 1/	Job	1	1,200,000	1,200,000
Sanitary facilities 2/	Job	1	1,204,000	1,204,000
Beach development	Job	4	430,000	1,720,000
Trails	Mile	7	7,800	55,000
Landscaping	Acre	3655	250	914,000
Utilities	Job	1	152,000	152,000
Signs	Job	1	20,000	20,000
Interpretive Center	Each	1	150,000	150,000
Incinerator	Each	3	4,000	12.000
Interpretive Aids 3/	Each	1	75,000	75,000
Subtotal, facilities				$ 10,282,000
Contingencies				1,542,000
Subtotal				$ 11,824,000
Engineering and Design and Supervision and Administration				2,140,000
TOTAL, FACILITIES				$ 13,964,000
REAL ESTATE				
Lands	Acre	8,600	-	$ 2,079,150
Improvements	L.S.	-	-	1,708,000
Contingencies	L.S.	-	-	946,850
Administrative & Resettlement Cost	L.S.	-	-	207,000
TOTAL, REAL ESTATE				$ 4,941,000
TOTAL, LANDS AND FACILITIES				$ 18,905,000

1/ Includes treatment & distribution system

2/ Includes restrooms, showerhouses, washhouses and collection and treatment system.

3/ Includes goose breeding pen, satellite ponds, nature trails, observation mounds and parking lots.

TABLE 14-41

DETAILED SUMMARY OF CONSTRUCTION AND INVESTMENT COSTS AND ANNUAL CHARGES
GENERAL RECREATION, FISH AND WILDLIFE RECREATION AND INVIOLATE REFUGE
THE SELECTED PLAN OF DEVELOPMENT - WHITEOAK DAM AND RESERVOIR

	CONSTRUCTION COSTS			INVESTMENT COSTS Interest During Construction (4 yrs)		
Item	Facilities	Lands	Total	Facilities	Lands	Total
General Recreation	$ 13,432,500	$ 2,024,000	$15,456,500	$ 873,100	$ 131,600	$ 16,461,200
Fish and Wildlife	431,500	1,458,500	1,890,000	28,000	94,800	2,012,800
Inviolate Refuge	100,000	1,458,500	1,558,500	6,500	94,800	1,659,800
Total	$ 13,964,000	$ 4,941,000	$18,905,000	$ 907,600	$ 321,200	$ 20,133,800

ANNUAL CHARGES, SPECIFIC-USE LANDS AND FACILITIES

Interest on Investment 1/	$ 654,400
Amortization on Investment 1/	27,800
Major replacements 2/	97,300
Operation and maintenance 3/	205,500
Loss in land productivity 4/	45,500
Total, Annual Economic Charges	$ 1,030,500
Total, Annual Financial Charges	$ 985,000
ALTERNATIVE COST OF RECREATION	$ 1,143,100

1/ Interest and Amortization - 3.125%, project life 100 years; amortization factor .00138
2/ Major Replacements - Initial facilities x 1/3 x 0.0252
3/ O&M - $0.20 per visitor day + Fish and Wildlife
4/ Loss in Land Prod. (5.00 - 3.125)

16. DEVELOPMENT PLAN COSTS

Investment costs are based on data included in Exhibit 14-31. Projected expenditures for 10-year intervals were made for the developmental plan from 1975 through 2025. These projections were made for both Federal and non-Federal investments. All investments were assumed to be uniform during each year of the 10-year intervals. Federal investments were classified entirely as public, with an estimated life of 50 years. Non-Federal investments were broken down into the following categories: residential, public, industrial and commercial. Residential and public are assumed to have useful lives of 50 years. Industrial and commercial are assumed to consist of 50 percent equipment, with a 25-year useful life, and the remaining 50 percent having a 50-year life. Major replacements were phased in for both Federal and non-Federal investments in accord with these assumptions for the 100-year project life. All yearly investments were converted to present worth values by use of 3.25 percent interest and amortization table. The accumulated present worth of Federal and non-Federal investments then were spread over project life at 3.25 percent and 5 percent interest rates, respectively. Summaries of investment costs and annual charges for Plan A - Without the Refuge and Plan B - With the Refuge are presented in Tables 14-42 and 14-43, respectively.

Expenditures made by recreationists and tourists also will induce commercial investment. Similar economic activity is induced by the cycle of respending of wages earned from direct employment on project construction, operation and maintenance, and in establishments serving the recreationists. Estimates of local expenditures by recreation users were based on projected visitation, and the amount expended per visitor was varied depending on travel distance to reach the project. Local income resulting from the recreation visitor expenditures and the multiplier effect was determined during the calculation of developmental benefits. Local expansion of business and commercial facilities is directly related to this increased income.

The total increase in local expenditures or sales was estimated and used to determine investment amounts. Consideration of total sales, average sales per square foot of facility floor space, and average facility cost per square foot of floor space produced the investment cost. Average annual charges were discounted over the 100-year economic life of the project, assuming a 5 percent private interest rate. These development costs do not reflect the induced investments that are expected to occur outside the Appalachian region. The commercial investment costs for these two effects also are included in Tables 14-42 and 14-43.

TABLE 14-42

DEVELOPMENT PLAN INVESTMENT COSTS
AND ANNUAL CHARGES ($1,000)
WHITEOAK CREEK BASIN, OHIO
PLAN A - WITHOUT THE REFUGE

Sector	Federal	Non-Federal	Total
Total Investment (1975-2025)			
Industrial and commercial	$ --	$ 184,081	$184,081
Commercial 1/	--	1,704	1,704
Residential	--	205,616	205,616
Public facilities	$26,979	27,381	54,360
Totals	$26,979	$ 418,782	$445,761
Annual Charges			
Industrial and commercial	$ --	$ 7,145	$ 7,145
Commercial 1/	--	126	126
Residential	--	6,315	6,315
Public facilities	689	934	1,623
Totals	$ 689	$ 14,520	$ 15,209

1/ Private investment to support developmental effects of recreation visitor expenditures and respending of redevelopment wages for reservoir project with refuge.

TABLE 14-43

DEVELOPMENT PLAN INVESTMENT COSTS
AND ANNUAL CHARGES ($1,000)
WHITEOAK CREEK BASIN, OHIO
PLAN B - WITH THE REFUGE

Sector	Federal	Non-Federal	Total
	Total Investment (1975-2025)		
Industrial and commercial	$ --	$184,081	$184,081
Commercial 1/	--	1,520	1,520
Residential	--	205,616	205,616
Public facilities	26,979	27,381	54,360
Totals	$26,979	$418,598	$445,577
	Annual Charges		
Industrial and commercial	$ --	$ 7,145	$ 7,145
Commercial 1/	--	112	112
Residential	--	6,315	6,315
Public facilities	689	934	1,623
Totals	$ 689	$ 14,506	$ 15,195

1/ Private investment to support developmental effects of recreation visitor expenditures and respending of redevelopment wages for reservoir project with refuge.

17. SUMMARY

The selected plan of development for the Whiteoak Dam and Reservoir would provide tangible benefits which have been classified into two categories - user and expansion. Various portions of both of these categories would be ascribable to either the national efficiency economic account or the regional economic account. Other portions would be credited to both accounts. Subsequent paragraphs in this section contain discussions on procedures and techniques used to measure the anticipated benefits. Average annual benefits for the selected plan of development are summarized on Table 14-44.

18. USER

Flood Control. Flood damage surveys within the Whiteoak Basin disclosed a negligible amount of damages along Whiteoak Creek and its major tributaries. Therefore, flood control benefits have been claimed only along the Ohio River. Average annual damages prevented by Whiteoak Reservoir on the Ohio River would amount to $108,900 annually based on the prices and level of development existing in July 1968. These damages prevented reflect Whiteoak Reservoir acting in first place after "1965 Group A" Ohio River Basin reservoirs. Flow-frequency data were prepared for affected reaches along the Ohio River by the U. S. Army Engineer Division, Ohio River, which reflected the flow reductions effected by the system of reservoirs in the Ohio River Basin. The flow-frequency data were related by one-foot increments to stage-damage curves and converted to dollar damage increments per 1,000 cubic feet per second of flow by applying at each interval the rate of change in stage per 1,000 cubic feet per second as determined from a crest stage-discharge relationship curve. The capability of the reservoir under study for reducing crest flows at the various recurrence intervals were determined by standard methods and the flow reductions were then converted to dollar benefits at each interval using the dollar damage increments per 1000 cubic feet per second of flow. The sum of the increments becomes the average annual damages prevented. Average annual benefits over the 100 year life of the project would be $257,300 in July 1968 prices and assuming a 3.0 percent straight-line growth in the affected reaches downstream from the mouth of Whiteoak Creek.

General Recreation and Fish and Wildlife Enhancement. Extensive studies were undertaken jointly by the Bureau of Outdoor Recreation, the U. S. Fish and Wildlife Service, the State of Ohio Department of Natural Resources and the Corps of Engineers to evaluate the general recreation and fish and wildlife enhancement potential of the Whiteoak Reservoir. Fish and wildlife benefits were based on estimates furnished by the U. S. Fish and Wildlife Service and general recreation benefits were based on estimates furnished by the Bureau of Outdoor Recreation. All interests consider the project to offer a somewhat unique experience because of the variety of activities available in the proximity

TABLE 14-44

WHITEOAK DAM AND RESERVOIR
AVERAGE ANNUAL BENEFITS FOR THE SELECTED PLAN OF DEVELOPMENT

Category and Class of Benefits	ANNUAL BENEFITS ($1,000) National account only	Regional account only	Common to both accounts	Total National	Total Regional
User Benefits					
Flood Control	257	-	-	257	-
Water Supply	-	-	216	216	216
Water Quality Control	-	-	170	170	170
Recreation	1,015	-	435	1,450	435
Total User Benefits	1,272	-	821	2,093	821
Expansion Benefits					
Redevelopment	-	175	106	106	281
Development					
Wages - water proj. emp. 1/	-	1,092	184	184	1,276
Wages - indust. dev.	-	75,585	11,717	11,717	87,302
Return on invest. 2/	-	13,914	-	-	13,914
Total Expansion Benefit	-	90,766	12,007	12,007	102,773
Total Benefits	1,272	90,766	12,828	14,100	103,594

1/ Derived from recreation visitor expenditures and multiplier effect on redevelopment benefits.
2/ Value not used to compute indexes of performance.

3

of a major metropolitan area. The user areas would be unusually well developed and maintained. It, therefore, was considered appropriate to apply a monetary unit benefit value of $1.25, which is in the upper bracket of the range provided for by Senate Document No. 97. A major factor in selecting this unit value per recreation-day was the recognition of the extreme scarcity of outdoor recreation facilities in the Cincinnati region relative to its increasing population.

The establishment of a major migratory goose refuge and managed hunting area will offer the recreation visitor a unique experience. Benefits deriving therefrom would include waterfowl hunting, production and preservation of migratory geese, sightseeing, nature study and photography in the goose management unit.

A summary of the general and fish and wildlife recreation visitation and benefits is given in Table 14-45. Because of the extensive demand, maximum visitation is expected immediately after completion of the project.

TABLE 14-45

WHITEOAK DAM AND RESERVOIR
SUMMARY OF RECREATION VISITATION AND BENEFITS
FOR THE SELECTED PLAN

	Visitor Days	Average-annual Benefits
Recreation	950,000	$ 1,187,500
Fishery	13,560	13,560
Upland hunting	(No increase)	-
Waterfowl hunting	6,500	37,600
Nature study, etc.	43,500	87,000
Goose production and preservation	-	124,300
Total recreation visitation	1,013,560	
Total recreation benefits (rounded)		$ 1,450,000

Water supply and water quality control. The Federal Water Pollution Control Administration developed the water supply and water quality control needs to the year 2020 based on the level of economic development projected by the Corps of Engineers assuming full realization of the "benchmark" objectives. The 2020 needs were extended to the 100th year of the project's economic life by simple straight-line projection. A discussion of the projected needs is contained in Section II of this chapter. As discussed in paragraph 6 of that section, it was determined that the least expensive alternative to providing storage in the selected multiple purpose project would be a single purpose reservoir on Whiteoak Creek in the vicinity of New Hope. The average annual cost of providing such a project would amount to $216,100 for water supply and $170,200 for water quality control. These average annual costs for the single purpose alternatives were ascribed to the multiple purpose project as the benefits for the water supply and water quality control functions.

19. EXPANSION

Expansion benefits are divided into two categories, redevelopment and development. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation and maintenance of the water resource project. Developmental benefits result from wage payments made to persons within the region not directly associated with the project, but whose employment results from the economic activity induced by the water project development.

Redevelopment Benefits. Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor wages earned in the construction, operation and maintenance of the water resource projects and spent within the region. Benefits credited to the National account are the wages earned by persons who would otherwise be unemployed or underemployed in the absence of the water project construction.

To determine redevelopment benefits it is necessary to determine the portion of the total construction and operation and maintenance cost that accrue as wages. For this report, labor wages were estimated to be 25 percent of the construction cost less lands and damages, permanent operating equipment, engineering and design, and supervision and administration, and 70 percent of the operation and maintenance expenditures. All of these wages are creditable to the regional account. It is estimated that 44 percent of the wages would be earned by persons previously unemployed or underemployed (unskilled and semiskilled) and would therefore accrue to the National account.

Table 14-46 summarizes the annual redevelopment benefits creditable to the regional and National accounts.

TABLE 14-46

REDEVELOPMENT BENEFITS
WATER RESOURCE PROJECT
WHITEOAK DAM AND RESERVOIR

	Expenditure	Labor Cost 1/	Annual Redevelopment Benefits National account 2/	Annual Redevelopment Benefits Regional account 3/
Construction	$ 27,736,000	$6,934,000	$ 83,000	$ 135,000
Annual Operation & Maintenance	260,000	182,000	22,800	146,000
Total Benefits (rounded)			$106,000	$ 281,000

1/ Labor cost, including supervisors, estimated to be 25 percent of contract cost; approximately 70 percent of operation and maintenance expenditures.

2/ For construction, 80 percent of unskilled and semiskilled labor are from Appalachian counties and previously underemployed. For operation and maintenance, all of the unskilled and semiskilled labor are from Appalachian counties and also previously underemployed. No skilled labor included as previously unemployed. Value assumed to decline to zero in 20 years.

3/ For construction, approximately 60 percent of total wages represents new income to Appalachian counties. For operation and maintenance, 80 percent of annual payroll represents new income to Appalachian counties.

Developmental benefits. The amount of developmental benefits is measured as increased income. Primary sources of this new income are recreation visitor expenditures and the industrial expansion associated with the development plan, and water project employment.

Recreation expenditures. The level of recreational usage of Whiteoak Reservoir will be substantial. Commercial investment induced by recreation visitor expenditures will generate wages, salaries, and profits that can be designated as developmental benefits. The following tabulation presents the origin and the annual expenditures of the general recreationists estimated to use the project facilities:

Annual Visitation	Distance Traveled (mi.)	Percent of Total Visitation	Daily Expenditures per Visitor	Total Annual Expenditures
950,000	0-25	25	$ .50	$ 118,800
950,000	26-50	40	1.00	380,000
950,000	51-75	20	2.00	380,000
950,000	More than 76	15	4.00	570,000

Annual General Recreation Expenditures = $1,448,800

The report by the U. S. Fish and Wildlife Service for Whiteoak Reservoir (Appendix G) indicates that annual expenditures of $441,400 would result from hunting, fishing, and nature study visitation. This total combined with the general recreation expenditures would result in a total annual recreation visitor expenditure of $1,890,000. For this study it was estimated that 25 percent of the visitor expenditures would result in wages and salaries to individuals. Additional income would result to the region due to the respending cycle of the basic wages resulting from the visitor expenditure. The additonal income was evaluated utilizing county multipliers as developed in the study, "Recreation as an Industry", prepared by Robert R. Nathan Associates, Inc., Dec. 1966. The total of the basic wages plus the multiplier effect constitutes the benefits creditable to the regional account. The wages earned by persons previously unemployed or under-employed are creditable as benefits to the National account. It was assumed that over a period of 20 years the area would gradually approach full employment, and accordingly, benefits to the National account were discounted to reflect this condition. Increased income generated by recreation visitor expenditures include annual amounts of $104,000 and $946,000 that are creditable to the National and regional accounts, respectively.

Industrial expansion. The growth of local manufacturing industry will increase manufacturing employment directly and will increase employment indirectly in local supporting industries. Wages to be earned through new jobs created within Brown County as a result of the development plan can be claimed as expansion benefits attributable to the plan. In 2020, projected employment with the development plan is significantly greater than projected employment without the plan. The difference between the two projections, or, the number of jobs in Brown County that could be attributed to the development plan would be 14,600. The projected increase in the manufacturing and service employment by place of residence with the development plan is 13,500 (See Exhibit 14-30, Tables III and IV); however, a projected decrease in commuting out of the county would result in the estimated 14,600 induced jobs by place of employment (in Brown County). Employment would be in manufacturing (5,700 jobs) and service industries (8,900 jobs). Service industries are defined as transportation, communication, utilities, wholesale and retail trade, finance, insurance, real estate, personal service, construction, and government service. Skill levels of manufacturing and service employees used in this study include management, skilled, semiskilled, and unskilled. The percentage of employees at each skill level is shown in Table 14-47.

In 1960, the unemployed and underemployed labor force in the four-county area was determined to be about 8700 persons. As economic growth occurs, some of these people will be employed, initially filling only semiskilled and unskilled positions. The younger, more capable people will be encouraged, because of more job opportunities, to stay in the area instead of migrating. One 1966 estimate indicated that 85 percent of high school graduates leave the county for opportunities elsewhere. The number of workers required from outside the four county area to fill manufacturing and service jobs would diminish as the local people become more able to meet the demand for labor at all skill levels. An estimate of the ratio of imported labor to local labor in the year 2020 has been incorporated into Table 14-48.

TABLE 14-58

TABLE 14-47

MANUFACTURING AND SERVICE EMPLOYEES BY SKILL LEVELS - 2020

	Total	Management	Skilled	Semiskilled	Unskilled
Manufacturing					
Percent	100	8.3	21.9	42.7	27.1
Number	5700	475	1250	2435	1540
Service					
Percent	100	10	25	40	25
Number	8900	890	2225	3560	2225
Total	14,600				

TABLE 14-48

SOURCE OF MANUFACTURING EMPLOYEES - 2020

Skill	Total Employees	Local Employees Percent	Local Employees Employees	Imported Employees Percent	Imported Employees Employees
Management	475	40	190	60	285
Skilled	1,250	90	1,125	10	125
Semiskilled	2,435	100	2,435	0	0
Unskilled	1,540	100	1,540	0	0
Total	5,700		5,290		410

SOURCE OF SERVICE EMPLOYEES - 2020

Skill	Total Employees	Local Employees Percent	Local Employees Employees	Imported Employees Percent	Imported Employees Employees
Management	890	60	534	40	356
Skilled	2,225	75	1,669	25	556
Semiskilled	3,560	100	3,560	0	0
Unskilled	2,225	100	2,225	0	0
Total	8,900		7,988		912

Local wage rates were applied to the various skill levels to provide yearly wages in terms of 1967 dollars. An estimate of the value of jobs in 2020 was obtained by applying a 2.0 percent increase compounded annually beginning in 1967. This factor was derived in "Expansion Benefits Analysis for the Salyersville-Royalton Area Pilot Project." The wage data is developed in Table 14-49, and the wage level expected in 2020 is summarized in Table 14-50. The wages received are a direct measure of developmental expansion benefits.

TABLE 14-49

MANUFACTURING AND SERVICES WAGE RATES BY SKILL LEVEL

Employment Sector and Skills	Hourly Wages 1967	Yearly Wages 1967	Yearly Wages 2020
Manufacturing			
Management	$3.60	$ 7,500	$ 21,400
Skilled	2.20	4,575	13,000
Semiskilled	1.60	3,330	9,500
Unskilled	1.35	2,800	8,000
Service			
Management	2.65	5,500	15,750
Skilled	1.80	3,750	10,750
Semiskilled	1.35	2,800	8,000
Unskilled	1.25	2,600	7,500

TABLE 14-50

WAGE LEVEL IN 2020

Type of Employment by Skill Level		Number of Employees	Wages in 2020 Per Employee	Wages in 2020 Total
Imported Employment				
Manufacturing Management		285	$ 21,400	$ 6,099,000
Manufacturing Skilled		125	13,000	1,625,000
Service Management		356	15,750	5,607,000
Service Skilled		556	10,750	5,977,000
Total Imported		1,322		$ 19,308,000
Local Employment				
Manufacturing	Management	190	21,400	4,066,000
	Skilled	1,125	13,000	14,625,000
	Semiskilled	2,435	9,500	23,132,500
	Unskilled	1,540	8,000	12,320,000
Service	Management	534	15,750	8,410,500
	Skilled	1,669	10,750	17,941,750
	Semiskilled	3,560	9,500	33,820,000
	Unskilled	2,225	7,500	16,687,500
Total Local		13,278		$ 131,003,250
Total Employment Wages Per Year in 2020				$ 150,311,250

Table 14-51 shows the expected wage level at ten year intervals.

TABLE 14-51

WAGE LEVEL ($1,000)

Type of Employment	Year 1980	1990	2000	2010	2020
Imported	765	12,520	22,985	23,220	19,308
Local	1,068	21,250	56,487	84,235	131,003
Total	1,833	33,771	79,472	107,455	150,311

The wages of imported employees were assigned to the regional account. Local employees who would be unemployed without the developmental plan are assignable to the National and regional account. In consideration of future programs that would serve to reduce unemployment without the envisioned development, the local wages assigned to the National account were arbitrarily reduced to ten percent by the end of 25 years. A level of ten percent was assigned thereafter. After the National wage assignment is made, the remaining local wages were assigned to the regional-only account. The regional account reflects the total wages generated by the development plan. Wages for each year were discounted to 1975 at 3.25 percent interest rate.

In addition to wages and salaries, profits computed annually as ten percent of industrial and commercial investment in place each year are credited to the regional account. Replacement investments are not included in this computation.

Water Project Employment. In the evaluation of redevelopment benefits, additional regional income resulting from the respending of the wages earned by direct employment on water project construction and operation was calculated. This secondary wage benefit was evaluated by use of county multipliers developed in "Recreation as an Industry", by Robert R. Nathan Associates, Inc., and is creditable as a developmental benefit. The average regional multiplier, with a value of two, was applied to the portion of the construction and operation wages spent within the area, to obtain the additional income benefits creditable to the regional account. The portion of the wages earned by the previously unemployed or under-employed, discounted to zero over a 20-year period, accrues as benefits to the National acocunt.

A summary of developmental expansion benefits is presented in Table 14-52.

TABLE 14-52

SUMMARY OF DEVELOPMENTAL EXPANSION BENEFITS

Source of Benefit	Accumulated Present Worth 1/	Average Annual Equivalent
Recreation Visitor Expenditures		
Wages		
National account	$ 3,070,000	104,000 2/
Regional account	27,922,000	946,000 2/
Industrial Expansion		
Wages		
National account	345,853,000	11,717,000 2/
Regional account	2,576,032,000	87,302,000 2/
Profit		
Regional account	276,179,000	13,914,000 3/
Water Project Employment		
National account		80,000 2/
Regional account		330,000 2/
Total regional account		$ 102,492,000
Total National account		$ 11,901,000

1/ Converted to present worth values by 3.25 percent interest rate.
2/ Discounted over project life at 3.25 percent interest rate.
3/ Discounted over project life at 5 percent interest rate.

20. ECONOMIC DATA

Project costs. Annual economic charges were computed utilizing data developed in the cost estimate presented in Section IV of this chapter. These charges differ slightly from the financial annual charges computed for the Whiteoak Dam and Reservoir. The difference results from allowing for loss of land productivity which is based on five percent annual net income on lands taken for the project. A summary of costs for Whiteoak Dam and Reservoir is shown in Table 14-53.

TABLE 14-53
THE SELECTED PLAN
WHITEOAK DAM AND RESERVOIR

SUMMARY OF COSTS
(July 1967 Prices)

CONSTRUCTION COST 1/	
Lands and damages	$ 7,229,000
Relocations	2,398,000
Reservoir	392,000
Dam and appurtenances	15,830,000
Recreation	13,964,000
Permanent operating equipment	218,000
TOTAL	$40,031,000
ANNUAL CHARGES	
Interest at 3-1/4 percent	$ 1,385,600
Amortization in 100 years	58,900
Maintenance and operation	260,500
Major replacements	99,500
Subtotal, financial charges	$ 1,804,500
Land productivity loss	69,200
TOTAL, WATER RESOURCE PROJECT ECONOMIC CHARGES	$ 1,873,700
Development Plan investment costs 2/	15,195,000
TOTAL, PUBLIC AND PRIVATE ANNUAL CHARGES	$17,068,700

1/ Cost shown includes cost of engineering, design, supervision and administration

2/ Includes $689,000 of Federal funds and $934,000 of non-Federal funds for Public facilities.

Development plan investment costs. Annual charges for this feature amount to $15,195,000, based on a total investment of $445,577,000. Discussion concerning procedures used to develop the estimated cost of the investment is presented in paragraph 16 and Exhibit 14-31.

Project and development plan benefits. Annual economic benefits developed and discussed in Section V are summarized in Table 14-54.

TABLE 14-54
SUMMARY OF ANNUAL BENEFITS
THE SELECTED PLAN
WHITEOAK DAM AND RESERVOIR
(in $1000)

Type of Benefit	National	Regional
User	$ 2,093	$ 821
Redevelopment	106	281
User plus Redevelopment	(2,199)	(1,102)
Development	11,901	88,578
Expansion (Redevelopment plus Development)	12,007	88,859
TOTAL BENEFITS	$14,100	$89,680

21. INDEXES OF PERFORMANCE

One index of performance can be evaluated by reliance on the conventional ratio of benefits-to-costs generally developed for water resource projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water projects (redevelopment benefits). The denominator is the annual economic cost of the water projects. Such an index, computed below, expresses the minimum index of performance in regard to national income augmentation.

$$\frac{2,199,600}{1,873,700} = 1.2$$

Another index of performance gives a relative measure of the contribution that the Whiteoak development would make to the objective of employment expansion. The numerator consists of increased wage payments for construction and operation of the water project plus wages and salaries and other income flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{88,859,000}{17,068,700} = 5.2$$

22. ALLOCATION OF COSTS

Costs of the Whiteoak Dam and Reservoir project were allocated by the separable cost-remaining benefit method. Purposes among which costs were allocated include flood control, water supply, water quality control, recreation and regional economic expansion. Table 14-55 summarizes the construction expenditures, annual operation, maintenance and major replacement costs, total capital investment costs and annual charges for Plan A - Without the Refuge. The allocation is given in Table 14-56 with a sub-allocation between general recreation and fish and wildlife enhancement in Table 14-57. A comparable summary, allocation and sub-allocation for the selected plan, Plan B - With the Refuge, are contained in Tables 14-58, 14-59 and 14-60, respectively. Further, a sub-allocation between the inviolate waterfowl refuge and the remaining fish and wildlife developments is contained in Table 14-61.

Alternative costs. To provide an equitable basis for allocation of project costs to each purpose, the benefits for each purpose were limited to the cost of providing an alternative single purpose project, where such alternative costs would be less than or equal to the estimated benefits. The alternative costs for the flood control function, as summarized in Tables 14-55 and 14-58 for the two plans, were based on actual estimates of the cost of providing a single purpose flood control project at the site selected for the multiple purpose project.

The alternative costs for the recreation function were developed from statistical data compiled by the Corps of Engineers. The determination is discussed in detail in paragraph 14. Alternative costs for both water supply and water quality control were based on estimates developed by the Federal Water Pollution Control Administration. The regional expansion alternative costs were developed by using a single-purpose state park type development and the developmental plan plus an adjustment to make the redevelopment benefit of the alternate equal to that of the reservoir plan.

Separable costs. The incremental costs for adding each purpose to an alternative multiple purpose project omitting that purpose are the "Separable" costs as shown in Tables 14-56 and 14-59. These separable costs amount to the difference between the cost of the multiple purpose project and the cost of a project at the same site containing all purposes except the one being separated. The costs for the alternative multiple purpose projects omitting one purpose each are summarized in Tables 14-55 and 14-58.

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ANALYSIS OF CONST

PLA
WHITEOAK

Item	Multiple Purpose Reservoir: Specific Use Lands & Facilities: Regional Economic Expansion	Water Quality	Recreation	Water Supply	Joint Use Costs	Total Cost
Construction First Cost						
Lands and damages	$ -	$ -	$ 2,883.2	$ -	$ 2,218.8	$ 5,10
Relocations	-	-	-	-	3,119.0	3,11
Reservoir & pool preparation	-	-	-	217.0	173.0	39
Dam & appurtenances	-	46.0	-	-	15,724.0	15,77
Recreation facilities	-	-	18,301.0	-	-	18,30
Permanent operating equipment	-	14.0	-	-	204.0	21
Construction costs (water project)	-	60.0	21,184.2	217.0	21,438.8	42,90
Development plan	445,761	-	-	-	-	445,76
Total construction costs	445,761	60.0	21,184.2	217.0	21,438.8	488,66
Investment Costs						
Initial Construction Costs	-	60.0	21,184.2	217.0	21,438.8	42,90
Interest during construction	-	3.9	1,377.0	14.1	1,393.5	2,78
Investment cost, initial increment	-	63.9	22,561.2	231.1	22,832.3	45,68
Future recreation facilities	-		No Future Facilities			
Development plan	445,761	-	-	-	-	445,76
Total investment costs	445,761	63.9	22,561.2	231.1	22,832.3	491,44
Annual Financial Charges						
Initial Increment						
Interest & amortization	15,209.0	2.2	764.3	7.8	773.5	16,75
Operation & maintenance						
Recreation	-	-	275.2	-	-	27
Dam	-	5.0	-	0	50.0	5
Major Replacement						
Recreation	-	-	130.4	-	-	13
Dam	-	0.2	-	0	2.0	
Total Annual Financial Charges	15,209.0	7.4	1,169.9	7.8	825.5	17,21

1/ Based on least expensive alternative as computed by Corps w/ needs developed by FWPCA, adju
and 3-1/4% interest rate.

2/ Amount computed based on statistical analysis of actual expenditures at similar developments

TABLE 14-55

ANALYSIS OF CONSTRUCTION, INVESTMENT AND ANNUAL COSTS
($1,000)

PLAN A - WITHOUT REFUGE
WHITEOAK DAM AND RESERVOIR PROJECT

	se Reservoir			Alternate Single Purpose Projects					Multiple Purpose P		
ities											
n	Water Supply	Joint Use Costs	Total Costs	Flood Control	Water Supply	Water Quality	Recreation	Regional Income Expansion	Flood Control	Water Quality	Recre
	$ -	$ 2,218.8	$ 5,102.0	$ 1,620.0	$	$	$	$	$ 4,900.0	$ 5,102.0	$ 2,
	-	3,119.0	3,119.0	1,401.0					2,076.0	3,119.0	2,
	217.0	173.0	390.0	120.0					378.0	390.0	
	-	15,724.0	15,770.0	15,332.0					12,944.0	15,619.0	15,
	-	-	18,301.0	-					18,301.0	18,301.0	
	-	204.0	218.0	207.0					183.0	204.0	
	217.0	21,438.8	42,900.0	18,680.0					38,773.0	42,735.0	21,
	-	-	445,761.0	-					445,761.0	445,761.0	445,
	217.0	21,438.8	488,661.0	18,680.0					484,534.0	488,496.0	467,
	217.0	21,438.8	42,900.0	18,680.0					38,773.0	42,735.0	21,
	14.1	1,393.5	2,788.5	1,214.0					2,520.2	2,777.8	1,
	231.1	22,832.3	45,688.5	19,894.0					41,293.2	45,512.8	22,
acilities											No Fut
	-	-	445,761.0	-					445,761.0	445,761.0	445,
	231.1	22,832.3	491,449.5	19,894.0					487,054.2	491,273.8	468,
	7.8	773.5	16,756.8	674.1					16,608.0	16,750.9	15,
	-	-	275.2	-					275.2	275.2	
	0	50.0	55.0	50.0					45.0	50.0	
	-	-	130.4	-					130.4	130.4	
	0	2.0	2.2	2.0					1.5	2.0	
	7.8	825.5	17,219.6	726.1	216.1 1/	170.2 1/	1,255.0 2/	17,183.0	17,060.1	17,208.5	16,

ds developed by FWPCA, adjusted to reflect 1974 initial use

ures at similar developments.

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...ts ...onal ...come ...ansion	Multiple Purpose Project Less Flood Control	 Water Quality	 Recreation	 Water Supply	 Regional Economic Expansion
	$ 4,900.0	$ 5,102.0	$ 2,219.0	$ 4,904.0	$ 5,102.0
	2,076.0	3,119.0	2,918.0	3,119.0	3,119.0
	378.0	390.0	375.0	174.0	390.0
	12,944.0	15,619.0	15,770.0	15,169.0	15,770.0
	18,301.0	18,301.0	-	18,301.0	18,301.0
	183.0	204.0	218.0	218.0	218.0
	38,773.0	42,735.0	21,500.0	41,885.0	42,900.0
	445,761.0	445,761.0	445,761.0	445,761.0	-
	484,534.0	488,496.0	467,261.0	487,646.0	42,900.0
	38,773.0	42,735.0	21,500.0	41,885.0	42,900.0
	2,520.2	2,777.8	1,398.0	2,722.5	2,788.5
	41,293.2	45,512.8	22,898.0	44,607.5	45,688.5
			No Future Facilities		
	445,761.0	445,761.0	445,761.0	445,761.0	-
	487,054.2	491,273.8	468,659.0	490,368.5	45,688.5
	16,608.0	16,750.9	15,984.8	16,720.2	1,547.8
	275.2	275.2	-	275.2	275.2
	45.0	50.0	55.0	55.0	55.0
	130.4	130.4	-	130.4	130.4
	1.5	2.0	2.2	2.2	2.2
183.0	17,060.1	17,208.5	16,042.0	17,183.0	2,010.6

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TABLE 14-56

ALLOCATION OF COSTS ($1,000)

PLAN A - WITHOUT REFUGE
WHITEOAK DAM AND RESERVOIR PROJECT

Item	User Effects				Regional Expansion Effects	Total
	Flood Control	Recreation	Water Supply	Water Quality		
1. Benefits	257.3	1,725.4	216.1	170.2	102,654.0	105,023.0
2. Alternative costs	726.1	1,255.0	216.1	170.2	17,183.0	19,550.4
3. Benefit limits	257.3	1,255.0	216.1	170.2	17,183.0	19,081.6
4. Separable costs	159.5	1,177.6	36.6	11.1	15,209.0	16,593.8
5. Remaining benefits	97.8	77.4	179.5	159.1	1,974.0	2,487.8
6. Allocation of restricted joint costs						
a. Remaining benefits	-	77.4	179.5	159.1	-	416.0
b. Ratio	-	.186	.432	.382	-	1.000
c. Allocated restricted costs	-	11.0	25.6	22.6	-	59.2 1/
7. Separable plus allocated restricted costs	159.5	1,188.6	62.2	33.7	15,209.0	16,653.0
8. Remaining benefits	97.8	66.4	153.9	136.5	1,974.0	2,428.6
9. Ratio	.040	.027	.064	.056	.813	1.000
10. Allocated joint costs 2/	22.7	15.3	36.3	31.7	460.6	566.6
11. Total allocated financial costs	182.2	1,203.9	98.5	65.4	15,669.6	17,219.6

ALLOCATION OF OPERATION, MAINTENANCE AND REPLACEMENT COSTS 3/

Item	Flood Control	Recreation	Water Supply	Water Quality	Regional Expansion Effects	Total
12. Separable OM&R Charges	10.7	405.6	0	5.2	-	421.5
13. Allocated joint OM&R 2/	1.7	1.1	2.6	2.3	33.6	41.3
14. Total allocated OM&R	12.4	406.7	2.6	7.5	33.6	462.8

ALLOCATION OF INVESTMENT COSTS

Item	Flood Control	Recreation	Water Supply	Water Quality	Regional Expansion Effects	Total
15. Annual investment costs	169.8	797.2	95.9	57.9	15,636.0	16,756.8
16. Capitalized investment costs 4/	5,011.3	23,534.8	2,830.3	1,708.8	458,364.3	491,449.5
17. Adjustment for discount on future increment	NO FUTURE INCREMENT					
18. Total allocated investment costs	5,011.3	23,534.8	2,830.3	1,708.8	458,364.3	491,449.5

ALLOCATION OF CONSTRUCTION COSTS

Item	Flood Control	Recreation	Water Supply	Water Quality	Regional Expansion Effects	Total
19. Investment in specific use lands & facilities	-	22,561.2	231.1	63.9	445,761.0	468,617.2
20. Investment in joint use lands & facilities	5,011.3	973.6	2,599.2	1,644.9	12,603.3	22,832.3
21. Interest on joint use lands and facilities	305.9	59.4	158.6	100.4	769.2	1,393.5
22. Allocated construction costs of joint use lands & facilities	4,705.4	914.2	2,440.6	1,544.5	11,834.1	21,438.8
23. Construction costs of specific use lands & facilities	-	21,184.2	217.0	60.0	445,761.0	476,222.2
24. Total allocated construction costs	4,705.4	22,098.4	2,657.6	1,604.5	457,595.1	488,661.0
25. Construction costs of future increment	NO FUTURE INCREMENT					
26. Construction costs of Development Plan	-	-	-	-	445,761.0	445,761.0
27. Construction costs of water project (Initial)	4,705.4	22,098.4	2,657.6	1,604.5	11,834.1	42,900.0
28. Total construction costs of water project	4,705.4	22,098.4	2,657.6	1,604.5	11,834.1	42,900.0

1/ Steps in determination of allocated restricted joint costs for recreation, water quality control and water supply.
(a) Derive separable costs in line 4 for all purposes in accordance with regular procedure - the difference between the cost of the multiple purpose project and the cost of the multiple purpose project with one purpose omitted.
(b) Subtract from the multiple purpose project the cost of the single purpose flood control project at the site.
(c) Subtract from remainder of (b) above the sum of separable costs allocated to recreation, water quality control and water supply. The remainder of this computation is the sum of the restricted joint costs ($59,200) that serve recreation, water quality control and water supply.
(d) The sum of the restricted joint costs are allocated in proportion to remaining benefits for the three purposes.

2/ In proportion to remaining benefits (line 8).

3/ There are no restricted joint OM&R costs to be allocated.

4/ Flood control, water quality control, water supply and recreation costs are capitalized to present worth by (29.5129) X annual investment costs. Remainder of capital costs are allocated to Regional Economic Expansion effects.

TABLE 14-57

SUB-ALLOCATION OF GENERAL RECREATION
AND FISH AND WILDLIFE ENHANCEMENT CONSTRUCTION COSTS

WHITEOAK DAM AND RESERVOIR PROJECT
PLAN A - WITHOUT REFUGE

(1)	Total specific costs for combined purposes	$ 21,184,200
(2)	Specific costs for general recreation	20,478,200
(3)	Specific costs for fish and wildlife	706,000
(4)	Total allocated costs for combined purposes	22,098,400
(5)	Total separable costs for combined purposes	21,400,000
(6)	Total joint costs for combined purposes (4)-(5)	698,400
(7)	Ratio, general recreation benefits to combined benefits	0.942
(8)	Joint costs allocated to general recreation (6)x(7)	657,900
(9)	Joint costs allocated to fish and wildlife (6)-(8)	40,500
(10)	Total separable costs other than specific costs (5)-(1)	215,800
(11)	Separable costs other than specific costs allocated to general recreation (7)x(10)	203,300
(12)	Separable costs other than specific costs allocated to fish and wildlife (10)-(11)	12,500
(13)	Separable costs allocated to general recreation (2)+(11)	20,681,500
(14)	Separable costs allocated to fish and wildlife (3)+(12)	718,500
(15)	Total construction costs allocated to general recreation (8)+(13)	21,339,400
(16)	Total construction costs allocated to fish and wildlife (9)+(14)	759,000

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ANALYSIS OF CONSTRUCTION,
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PLAN B -
WHITEOAK DAM A

Item	Multiple Purpose Reservoir — Specific Use Lands & Facilities: Regional Economic Expansion	Water Quality	Recreation	Water Supply	Joint Use Costs	T(
Construction First Cost						
Lands and damages	$	$ -	$ 4,941.0	$ -	$ 2,288.0	$ 7
Relocations		-	-	-	2,398.0	2
Reservoir & pool preparation		-	-	220.0	172.0	
Dam & appurtenances		46.0	-	-	15,784.0	1
Recreation facilities		-	13,964.0	-	-	1
Permanent operating equipment		14.0	-	-	204.0	
Construction costs (water project)		60.0	18,905.0	220.0	20,846.0	4(
Development plan	445,577.0	-	-	-	-	44
Total construction costs	445,577.0	60.0	18,905.0	220.0	20,846.0	48
Investment Costs						
Initial Construction Costs		60.0	18,905.0	220.0	20,846.0	4(
Interest during construction		3.9	1,228.8	14.3	1,355.0	
Investment cost, initial increment		63.9	20,133.8	234.3	22,201.0	4
Future recreation facilities			No future facilities			
Development plan	455.577.0	-	-	-	-	445
Total investment costs	455,577.0	63.9	20,133.8	234.3	22,201.0	488
Annual Financial Charges						
Initial Increment						
Interest & amortization	15,195.0	2.2	682.2	7.9	752.2	16
Operation & maintenance						
Recreation	-	-	205.5	-	-	
Dam	-	5.0		0	50.0	
Major Replacement						
Recreation	-	-	97.3	-	-	
Dam	-	0.2	-	0	2.0	
Total Annual Financial Charges	15,195.0	7.4	985.0	7.9	804.2	1

1/ Based on least expensive alternative as computed by Corps w/ needs developed by FWPCA, a

2/ Amount computed based on statistical analysis of actual expenditures at similar developme

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TABLE 14-58

ANALYSIS OF CONSTRUCTION, INVESTMENT AND ANNUAL COSTS
($1,000)

PLAN B - WITH REFUGE
WHITEOAK DAM AND RESERVOIR PROJECT

Purpose Reservoir Facilities				Alternate Single Purpose Projects					Multiple	
eation	Water Supply	Joint Use Costs	Total Costs	Flood Control	Water Supply	Water Quality	Recreation	Regional Income Expansion	Flood Control	Water Quality
941.0	$ -	$ 2,288.0	$ 7,229.0	$ 1,620.0	$	$	$	$	$ 7,229.0	$ 7,229.0
-	-	2,398.0	2,398.0	1,401.0					1,350.0	2,398.0
-	220.0	172.0	392.0	120.0					379.0	392.0
-	-	15,784.0	15,830.0	15,332.0					12,948.0	15,676.0
964.0	-	-	13,964.0	-					13,964.0	13,964.0
-	-	204.0	218.0	207.0					184.0	204.0
905.0	220.0	20,846.0	40,031.0	18,680.0					36,054.0	39,863.0
-	-	-	445,577.0	-					445,577.0	445,577.0
905.0	220.0	20,846.0	485,608.0	18,680.0					481,631.0	485,440.0
905.0	220.0	20,846.0	40,031.0	18,680.0					36,054.0	39,863.0
228.8	14.3	1,355.0	2,602.0	1,214.0					2,343.5	2,591.0
133.8	234.3	22,201.0	42,633.0	19,894.0					38,397.5	42,454.0
ure facilities										
-	-	-	445,577.0	-					445,577.0	445,577.0
133.8	234.3	22,201.0	488,210.0	19,894.0					483,974.5	488,031.0
682.2	7.9	752.2	16,639.5	674.1					16,495.9	16,633.4
205.5	-	-	205.5	-					205.5	205.5
	0	50.0	55.0	50.0					45.0	50.0
97.3	-	-	97.3	-					97.3	97.3
-	0	2.0	2.2	2.0					1.5	2.0
985.0	7.9	804.2	16,999.5	726.1	216.1 1/	170.2 1/	1,143.1	16,968.0	16,845.2	16,988.2

w/ needs developed by FWPCA, adjusted to reflect 1974 initial use and 3-1/4% interest rate.
penditures at similar developments.

3

Regional Income Expansion	Multiple Purpose Project Less: Flood Control	Water Quality	Recreation	Water Supply	Regional Economic Expansion
$	$ 7,229.0	$ 7,229.0	$ 2,346.0	$ 7,229.0	$ 7,229.0
	1,350.0	2,398.0	2,857.0	2,398.0	2,398.0
	379.0	392.0	376.0	170.0	392.0
	12,948.0	15,676.0	15,830.0	15,179.0	15,830.0
	13,964.0	13,964.0	-	13,964.0	13,964.0
	184.0	204.0	218.0	218.0	218.0
	36,054.0	39,863.0	21,627.0	39,158.0	40,031.0
	445,577.0	445,577.0	445,577.0	445,577.0	-
	481,631.0	485,440.0	467,204.0	484,735.0	40,031.0
	36,054.0	39,863.0	21,627.0	39,158.0	40,031.0
	2,343.5	2,591.0	1,406.0	2,545.0	2,602.0
	38,397.5	42,454.0	23,033.0	41,703.0	42,633.0
	445,577.0	445,577.0	445,577.0	445,577.0	-
	483,974.5	488,031.0	468,610.0	487,280.0	42,633.0
	16,495.9	16,633.4	15,975.4	16,608.0	1,444.5
	205.5	205.5	-	205.5	205.5
	45.0	50.0	55.0	55.0	55.0
	97.3	97.3	-	97.3	97.3
	1.5	2.0	2.2	2.2	2.2
16,968.0	16,845.2	16,988.2	16,032.6	16,968.0	1,804.5

nterest rate.

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TABLE 14-59

ALLOCATION OF COSTS ($1,000)

PLAN B - WITH REFUGE
WHITEOAK DAM AND RESERVOIR PROJECT

Item	User Effects: Flood Control	User Effects: Recreation	User Effects: Water Supply	User Effects: Water Quality	Regional Expansion Effects	Total
1. Benefits	257.3	1,450.0	216.1	170.2	102,773.0	104,866.6
2. Alternate costs	726.1	1,143.1	216.1	170.2	16,968.0	19,223.5
3. Benefit limits	257.3	1,143.1	216.1	170.2	16,968.0	18,754.7
4. Separable costs	154.3	966.9	31.5	11.3	15,195.0	16,359.0
5. Remaining benefits	103.0	176.2	184.6	158.9	1,773.0	2,395.7
6. Allocation of restricted joint costs						
a. Remaining benefits	-	176.2	184.6	158.9	-	519.7
b. Ratio	-	.340	.360	.300	-	1.000
c. Allocated restricted costs	-	23.4	24.7	20.6	-	68.7 1/
7. Separable plus allocated restricted costs	154.3	990.3	56.2	31.9	15,195.0	16,427.7
8. Remaining benefits	103.0	152.8	159.9	138.3	1,773.0	2,327.0
9. Ratio	.044	.066	.069	.059	.762	1.000
10. Allocated joint costs 2/	25.2	37.7	39.5	33.7	435.7	571.8
11. Total allocated financial costs	179.5	1,028.0	95.7	65.6	15,630.7	16,999.5
ALLOCATION OF OPERATION, MAINTENANCE AND REPLACEMENT COSTS 3/						
12. Separable OM&R Charges	10.7	302.8	0	5.2	-	318.7
13. Allocated joint OM&R 2/	1.8	2.7	2.9	2.4	31.5	41.3
14. Total allocated OM&R	12.5	205.5	2.9	7.6	31.5	360.0
ALLOCATION OF INVESTMENT COSTS						
15. Annual investment costs	167.0	722.5	92.8	58.0	15,599.2	16,639.5
16. Capitalized investment costs 4/	4,928.7	21,323.5	2,738.8	1,711.7	457,507.3	488,210.0
17. Adjustment for discount on future increment	No Future Increment					
18. Total allocated investment costs	4,928.7	21,323.5	2,738.8	1,711.7	457,507.3	488.210.0
ALLOCATION OF CONSTRUCTION COSTS						
19. Investment in specific use lands & facilities	-	20,133.8	234.3	63.9	445,577.0	466,009.0
20. Investment in joint use lands & facilities	4,928.7	1,189.7	2,504.5	1,647.8	11,930.3	22,201.0
21. Interest on joint use lands and facilities	300.8	72.6	152.9	100.6	728.1	1,355.0
22. Allocated construction costs of joint use lands & facilities	4,627.9	1,117.1	2,351.6	1,547.2	11,202.2	20.846.0
23. Construction costs of specific use lands & facilities	-	18,905.0	220.0	60.0	445,577.0	464.762.0
24. Total allocated construction costs	4,627.9	20,022.1	2,571.6	1,607.2	456,779.2	485,608.0
25. Construction costs of future increment	No Future Increment					
26. Construction costs of Development Plan	-	-	-	-	445,577.0	445,577.0
27. Construction costs of water project (Initial)	4,627.9	20,022.1	2,571.6	1,607.2	11,202.2	40,031.0
28. Total construction costs of water project	4,627.9	20,022.1	2,571.6	1,607.2	11,202.2	40,031.0

1/ Steps in determination of allocated restricted joint costs for recreation, water quality control and water supply.
(a) Derive separable costs in line 4 for all purposes in accordance with regular procedure - the difference between the cost of the multiple purpose project and the cost of the multiple purpose project with one purpose omitted.
(b) Subtract from the multiple purpose project the cost of the single purpose flood control project at the site.
(c) Subtract from remainder of (b) above the sum of separable costs allocated to recreation, water quality control and water supply. The remainder of this computation is the sum of the restricted joint costs ($68,700) that serve recreation, water quality control and water supply.
(d) The sum of the restricted joint costs are allocated in proportion to remaining benefits for the three purposes.

2/ In proportion to remaining benefits (line 8).

3/ There are no restricted joint O.M.& R. costs to be allocated.

4/ Flood control, water quality control, water supply and recreation costs are capitalized to present worth by (29.5129) X annual investment costs. Remainder of capital costs are allocated to Regional Economic Expansion effects.

5/ Negative values under recreation reflect actual decrease in joint use relocations costs when recreation is added as a purpose.

TABLE 14-60

SUB-ALLOCATION OF GENERAL RECREATION
AND FISH AND WILDLIFE ENHANCEMENT CONSTRUCTION COSTS

WHITEOAK DAM AND RESERVOIR PROJECT

PLAN B - WITH REFUGE

(1)	Total specific costs for combined purposes	$ 18,905,000
(2)	Specific costs for general recreation	15,456,500
(3)	Specific costs for fish and wildlife	3,448,500
(4)	Total allocated costs for combined purposes	20,022,100
(5)	Total separable costs for combined purposes	18,404,000
(6)	Total joint-use cost savings (1)-(5)	501,000
(7)	Total allocated joint and restricted costs (4)-(5)	1,618,100
(8)	Ratio general recreation benefits to combined benefits	0.819
(9)	Total savings for general recreation (6)x(8)	410,300
(10)	Total savings for fish and wildlife (6)-(9)	90,700
(11)	Separable costs allocated to general recreation (2)-(9)	15,046,200
(12)	Separable costs allocated to fish and wildlife (3)-(10)	3,357,800
(13)	Allocated joint and restricted costs for general recreation (7)x(8)	1,325,200
(14)	Allocated joint and restricted costs for fish and wildlife (7)-(13)	292,900
(15)	Total construction costs allocated to general recreation (11)+(13)	16,371,400
(16)	Total construction costs allocated to fish and wildlife (12)+(14)	3,650,700

TABLE 14-61

SUB-ALLOCATION OF INVIOLATE REFUGE
AND FISH AND WILDLIFE CONSTRUCTION COST

WHITEOAK DAM AND RESERVOIR PROJECT
PLAN B - WITH REFUGE

(1)	Total specific costs for combined purposes	$ 3,448,500
(2)	Specific costs for fish and wildlife	1,890,000
(3)	Specific costs for refuge	1,558,500
(4)	Separable costs for combined purposes	3,357,800
(5)	Joint-use cost savings for combined purposes (Table 14-60)	90,700
(6)	Ratio fish and wildlife benefits to combined benefits	0.526
(7)	Joint-use cost savings for fish and wildlife (5)x(6)	47,700
(8)	Joint-use cost savings for refuge (5)-(7)	43,000
(9)	Separable costs allocated to fish and wildlife (2)-(7)	1,842,300
(10)	Separable costs allocated to refuge (3)-(8)	1,515,500
(11)	Allocated joint and restricted costs for combined purposes (Table 14-60)	292,900
(12)	Allocated joint and restricted costs for fish and wildlife (6) x (11)	154,100
(13)	Allocated joint and restricted costs for refuge (11)-(12)	138,800
(14)	Total construction costs allocated to fish and wildlife (9)+(12)	1,996,400
(15)	Total construction cost allocated to refuge (10)+(13)	1,654,300

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SECTION VII - COST SHARING

23. APPORTIONMENT OF COST BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

Apportionment of costs for the multiple purpose Whiteoak Dam and Reservoir between Federal and non-Federal interests has been made according to the following criteria.

Water Supply. In accordance with the Water Supply Act of 1958, as amended, non-Federal interests have been apportioned all construction costs allocated to water supply, presently estimated to be $2,572,000. Local interests must also assume the annual operation, maintenance and major replacement costs allocated to water supply, estimated to be $2,900.

Recreation. The Federal Water Project Recreation Act of 1965 (PL 89-72) requires that non-Federal interests agree to administer project land and water areas for recreation and fish and wildlife enhancement and to bear not less than one-half the separable construction costs of the project allocated to those purposes and all separable costs for operation, maintenance and replacement. One-half of the allocated separable construction cost for general recreation presently is estimated to be $7,523,000 and operation, maintenance and replacement costs are estimated to be $285,300 annually. The remaining construction expenditures allocated to general recreation are apportioned to the Federal Government.

Fish and wildlife enhancement and migratory waterfowl refuge. Costs incurred specifically for the establishment of migratory waterfowl refuge uses in connection with an authorized Federal program are considered to be non-reimbursable in accordance with sub-section 6 (e) of the Federal Water Project Recreation Act of 1965 (PL 89-72). Initial enhancement costs allocated to the refuge portion of the management unit, presently estimated at $1,654,000, are considered to be non-reimbursable. Separable operation, maintenance and replacement costs allocated to the refuge portion of the management unit, presently estimated at $13,400 annually have been apportioned to non-Federal interests. For the balance of the management unit and other fish and wildlife developments, non-Federal interests have been apportioned one-half of the allocated separable construction costs, presently estimated at $921,000, and all of the allocated separable operation, maintenance and replacement costs presently estimated to be $4,100 annually. The costs associated with the balance of the management unit include the costs of lands and other needed facilities and equipment. The remaining construction expenditures allocated to the management unit and other fish and wildlife developments are apportioned to the Federal Government.

Water quality control. Section 2 of Public Law 87-88, 87th Congress, first session, states that if the benefits attributed to water quality control are identified as widespread or National in scope, the costs of water quality control features will be non-reimbursable. The Federal Water Pollution Control Administration concluded that the benefits of water quality control storage are widespread in scope. Therefore, all costs allocated to water quality control have been apportioned to the Federal Government. The report on "Water Resources Study - Whiteoak Creek Basin, Ohio", dated August 1962, has been re-evaluated based upon Developmental Benchmarks by the FWPCA in October 1967.

Flood control. All costs allocated to flood control have been apportioned to the Federal Government in accordance with the Flood Control Act of 1938.

Table 14-62 summarizes the apportioned costs by purpose between Federal and non-Federal interests for Whiteoak Reservoir and the associated project.

24. STATE AND LOCAL ASSURANCES

The principal issue raised by the assumptions underlying "benchmark" growth is whether private capital will be attracted to the area because of the availability of adequate water supply sources. The other favorable economic growth factors distinctly indicate that private investment would be induced, but the attainment of the projected levels of development necessary to justify the project is dependent upon the installation of public and private facilities such as roads and utilities and upon the enhancement of community amenities. In this respect, it is essential to justification of the project that local interests furnish reasonable assurances to the Secretary of the Army that such efforts are proceeding.

During detailed design studies that may follow, State or local interests must furnish formal assurances that they will pay the costs allocated to the water supply function of the project. At this time, it is considered that an indication of valid interest by a potential user is all that is necessary to permit advanced planning for the highest and best use of the available storage at the Whiteoak Reservoir site. Payment of first costs allocated to storage for current water supply use can be made by non-Federal interests during the construction phase of the project, or on an annual payment basis, as provided for by the Water Supply Act of 1958, as amended.

State or local interests also would be required to pay one-half of the separable construction costs allocated to recreation and all of the separable costs for operation, maintenance and major replacements for that function.

The Director of the Department of Natural Resources, State of Ohio, has indicated the State's intent to provide all necessary assurances required for both the water supply and recreation functions of the Whiteoak Dam and Reservoir. The Director's letter is included as Exhibit 14-27.

TABLE 14-62
SUMMARY OF APPORTIONED COSTS
BETWEEN FEDERAL AND NON-FEDERAL INTERESTS
FOR WHITEOAK RESERVOIR AND ASSOCIATED PROJECTS

Purpose	First Costs ($1,000)			Annual Operation, Maintenance, and Replacement Charges ($1,000)		
	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Flood Control	4,628	-	4,628	12.5	-	12.5
Recreation	11,578	8,444	20,022	2.7	302.8	305.5
Water Supply	-	2,572	2,572	-	2.9	2.9
Water Quality	1,607	-	1,607	7.6	-	7.6
Regional Expansion	11,202	-	11,202	31.5	-	31.5
Total Water Plan	29,015	11,016	40,031	54.3	305.7	360.0
Development Plan	26,979	418,598	445,577			
TOTAL PROJECT FIRST COSTS	55,994	429,614	485,608			

	Annual Charges ($1,000)		
	Federal	Non-Federal	Total
Water Plan	1,047.0	397.5	1,444.5
OM&R	54.3	305.7	360.0
Land Productivity Loss	69.2	-	69.2
Total Water Plan	1,170.5	703.2	1,873.7
Development Plan	689.0	14,506.0	15,195.0
TOTAL PROJECT ANNUAL CHARGE	1,859.5	15,209.2	17,068.7

JAMES A. RHODES
GOVERNOR

FRED E. MORR
DIRECTOR

STATE OF OHIO

DEPARTMENT OF NATURAL RESOURCES

OHIO DEPARTMENTS BUILDING
COLUMBUS 43215

August 29, 1969

Colonel John C. H. Lee, Jr.
Director, Office of Appalachian Studies
U. S. Army Corps of Engineers
Post Office Box 1159
Cincinnati, Ohio 45201

Development of Water Resources in Appalachia -
Whiteoak Dam and Reservoir Project

Dear Colonel Lee:

Reference is made to the draft report on the Whiteoak Dam and Reservoir Project recently furnished for our review and comments. This report and especially the selected plan of development were carefully reviewed.

We have noted that the economically optimum plan of development consisting of the multiple-purpose Whiteoak Dam and Reservoir Project and the Migratory Waterfowl Refuge will provide flood damage reduction, municipal and industrial water supply, improvement of water quality, outdoor recreation, and fish and wildlife enhancement. This project, as formulated, will provide significant economic benefits to the Whiteoak Creek Basin and Southwestern Ohio.

Under the authority granted the Director of the Department of Natural Resources in Section 1501.02, Ohio Revised Code, and acting as the designated representative of the Governor in matters of mutual interest to the Corps of Engineers and the State of Ohio, I concur with the selected plan of development. It will be the policy of the Department of Natural Resources under the provisions of the Federal Water Project Recreation Act to administer the project land and water areas for recreation and fish and wildlife enhancement; to bear one half the separable costs of the project allocated to these purposes, excluding the Migratory Waterfowl Refuge, and to operate, maintain and make replacement of facilities. The Department of Natural Resources will also administer the Migratory Waterfowl Refuge area and assume responsibility for operation, maintenance and replacement of facilities.

In accordance with the Water Supply Act of 1958, as amended, the Department of Natural Resources will administer the water supply feature of the project and will bear all costs allocated to this purpose.

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PARKS AND RECREATION • WATER • WATERCRAFT • WILDLIFE

The Ohio Water Pollution Control Board will, under existing authority and policy, require the maximum degree of treatment of waste waters discharged into the waters of the basin below Whiteoak Reservoir.

The State of Ohio will assume the leadership in taking such action as necessary to prevent diversion to other uses of any water quality storage provided in Whiteoak Reservoir. The State will also use every means available to protect the channels of Whiteoak Creek downstream from Whiteoak Reservoir from encroachment which would adversely affect operation of the project.

At such time as detailed planning is undertaken for the Whiteoak Dam and Reservoir Project, the State of Ohio, acting for itself or on behalf of any interested political subdivision, reserves the right to recommend to and negotiate with the Corps of Engineers concerning modifications or additional project purposes which may be deemed mutually desirable.

I wish to compliment you and the staff for the preparation of what we consider to be an excellent product. The investigations were thorough and carefully done. This, together with the orderly arrangement of the report, facilitated our review.

Your cooperation with the Department of Natural Resources and with other agencies of the State of Ohio during the preparation of the Whiteoak Reservoir Survey Report is appreciated.

Sincerely,

Fred E. Morr

FRED E. MORR
Director

FEM:bg

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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SECTION VIII - COORDINATION IN PLANNING

25. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture; Commerce; Interior; and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Huntington District of the Corps of Engineers or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

Many Federal agencies such as the U. S. Geological Survey, Environmental Science Services Administration, and the Office of Business Economics provided basic data for project planning, such as climatologic, streamflow, and economic records through regular publications or special reports. Other Federal agencies participated indirectly by assisting the state and local agencies and planning groups.

Several agencies made special studies as an aid in formulation and evaluation of the plan of development for Whiteoak Reservoir. Reports of these agencies are included in the appropriate appendixes to this report. The following paragraphs present recommendations or views of participating agencies, and actions taken.

Bureau of Outdoor Recreation. The report furnished by the Bureau of Outdoor Recreation recommends that sufficient facilities be provided to satisfy the requirements of the many varied recreational activities expected at the project. Adequate lands also should be acquired to support the necessary recreational development. The BOR recommends that at least 2,000 acres be purchased for general recreation. The plan presented herein includes 3,100 acres specifically for general recreation. Since proper balance must be maintained between visitation and water and land resources, the BOR suggests that the reservoir be zoned and that a limitation be placed on the horsepower of motors. This recommendation will be a part of the Department of Natural Resources consideration for operation and maintenance of the project, and would be in accordance with the administrative requirements of the operating agency, the Ohio Department of Natural Resources.

U. S. Fish and Wildlife Service. The Bureau of Sport Fisheries and Wildlife of the U. S. Fish and Wildlife Service evaluated and reported on the fish and wildlife conservation and enhancement aspects of the Whiteoak Reservoir. The report, included in Appendix G, contains the following nineteen recommendations:

"In the interest of insuring full development of fish and wildlife resources at the proposed White Oak Creek Reservoir, it is recommended that:

1. Conservation and development of fish and wildlife resources be one of the purposes for which the project is authorized.

2. Joint-use lands, from the dam downstream to the State Route 125 bridge, be developed to provide fishing access, and that parking facilities be provided for a design load of 5 angler cars in addition to those required for general recreation purposes.

3. A multiple-level outlet structure, with intake elevations at 815, 800, and 750 be provided to insure that reservoir releases will be of satisfactory quality for fish and other downstream uses.

4. The minimum discharge of water from the reservoir be not less than 5 c.f.s. at any time.

5. The bed of the stream in the tailwater be used as a source of fill for project purposes, and in so doing, effect the deepening of a series of tailwater pools to provide increased fish habitat.

6. Project land and water upstream from the White Oak Valley Road be licensed to the Ohio Department of Natural Resources under the terms of a Fish and Wildlife General Plan, except the area shown on the attached project outline map where the boundary line is undetermined and subject to future zoning regulations.

7. A reservoir zoning plan be developed in conjunction with preconstruction studies to insure that certain areas (or certain periods) will be available for fishing, hunting and other wildlife purposes, and that the plan be developed cooperatively by the Ohio Department of Natural Resources, the Corps of Engineers, the Bureau of Outdoor Recreation and the Bureau of Sport Fisheries and Wildlife.

8. Reservoir clearing plans be coordinated with the Ohio Department of Natural Resources and the Bureau of Sport Fisheries and Wildlife and that certain embayments be left virtually uncleared and other off-channel clearing be modified to provide in-reservoir fish habitat.

9. Parking and launching facilities for a design load of 75 automobiles and 45 boat trailers be provided for hunters and fishermen at various suitable locations on the reservoir in addition to the needs of general recreationists. One minimum facility access should be located on the refuge portion, the design and location of which to be decided during the advanced engineering studies.

10. Public fishing be permitted along the upstream face of the dam and in the tailwater and stilling basin, and that fishing platforms be constructed on the face of the dam to facilitate use of that area.

11. All lands below flood pool elevation plus those below an additional 300 feet on the horizontal or the succeeding five foot contour above the top of the flood pool, whichever is greater, be acquired in accordance with the provisions of the 1962 Joint Policy of the Departments of the Interior and the Army.

12. Approximately 5,500 acres of land be acquired and developed for wildlife enhancement and, together with approximately 2,400 acres of project land and waters and necessary initial developments, be turned over to the Ohio Department of Natural Resources for operation as a wildlife management unit under the provisions of a Fish and Wildlife General Plan.

13. Joint-use project lands north of the White Oak Valley Road and east of U. S. 68, be turned over to the Ohio Department of Natural Resources under a General Plan for fish and wildlife to serve as contingency land for the proposed wildlife management unit.

14. The costs of lands, facilities, and project modifications on the refuge portion of the management unit be considered non-reimbursable under the authority of Sub-section 6 (e) of the Federal Water Project Recreation Act, and that the lands and facilities on the balance of the management unit be cost-shared as set out by the above Act.

15. The major fall drawdown of the reservoir be delayed until November 15, or later, to facilitate waterfowl management.

16. To compensate for upland game losses, Federal recreation lands which are not too intensively developed be open to public hunting in accordance with policies of the Ohio Department of Natural Resources.

17. The following language be incorporated in the recommendations of the report of the Corps of Engineers: "That additional fish and wildlife studies be conducted as necessary after project authorization, and that such modifications be made in the authorized project facilities as may be agreed upon by the Chief of Engineers and the Director of the Bureau of Sport Fisheries and Wildlife."

18. The following language be incorporated in the recommendations of the report of the Corps of Engineers: "That federal lands and waters in the project area be open to public use for hunting, fishing, and wildlife-associated uses so long as title to the lands and structures be held by the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property."

19. The following language be incorporated in the recommendations of the report of the Corps of Engineers: "That leases of federal land in the project area reserve the right of public use of such land for hunting and fishing.""

The fish and wildlife recommendations are concurred in subject to the following comments:

Recommendation No. 5. It will be determined in the detailed planning stage of the Whiteoak Project if it is technically and economically feasible to utilize streambed material for construction fill. In any event, the Corps of Engineers will cooperate in determining if an alternative solution is available.

Recommendation Nos. 6, 12 and 13. The Director of the Ohio Department of Natural Resources indicated in his letter of comment to the Fish and Wildlife Service that the southern boundary of the management unit should be established as shown on Exhibit 14-26, in order to provide for a balance between wildlife interests and general recreation interests. The adjacent 42-acre area of the seasonal pool, as shown, would be restricted to preclude boating and its southern boundary would be marked with buoys. It is understood that this departure would not affect the economic evaluation of the management unit. The resulting land and water acreages are discussed in paragraph 14, Section III of this chapter.

Recommendation No. 10. Plans to permit fishing along the upstream face of the dam will be reviewed during the detailed planning stage of the Whiteoak Dam and Reservoir Project and will be included to the extent agreed upon by the operating agencies.

Recommendation No. 19. It is proposed to lease the project lands exclusive of the dam and appropriate operating areas to the Ohio Department of Natural Resources for use in accordance with plans set forth herein.

Federal Water Pollution Control Administration. A report of the Public Health Service dated August 1962, presented data and information relevant to the determination of present and future water requirements for municipal and industrial water supply and for water quality control within the basin.

A letter report, dated 13 October 1967, was submitted by the Federal Water Pollution Control Administration. This agency, under the Department of the Interior, submitted the original U. S. Public Health Service report used in preparation of this survey while under the U. S. Department of Health, Education, and Welfare. This letter report re-evaluated and updated the previously submitted report relative to present and future requirements for water supply, the increasing need for downstream dilutions of Georgetown waste effluents and better stream low flow regulation below the dam site. The letter report, included in Appendix D, presents needs data for the year 2020 based on "benchmark" projections provided by the Corps of Engineers. These data were projected over the 100 year economic life of the project by means of a simple straight line proportion. Evaluation of prospective water supply and water quality control benefits was prepared by the Corps of Engineers.

Federal Power Commission. The Federal Power Commission investigated two alternative plans for power development utilizing the proposed Whiteoak Reservoir. The Commission concluded that provisions for the possible future development of hydroelectric power at the proposed project would not be economically justified. These plans were formulated on pool levels which have subsequently been modified by the Corps in an effort to provide additional required releases. Their letter report is included as Exhibit 14-28.

U. S. Soil Conservation Service. The Soil Conservation Service was apprised of the earlier survey study of Whiteoak Creek in May 1962. The SCS indicated that they had no current interest in the basin. Subsequent to that time, a study of the Upper Whiteoak Creek Basin has been made and is included in Appendix A as part of the services' Appalachian Water Resource Study.

U. S. Bureau of Public Roads. The Bureau of Public Roads submitted certain information and cost data concerning the modification of Federal-aid highways within the reservoir area. The Bureau also gave assurance of future cooperation in all studies concerning the Whiteoak project.

National Park Service. The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

FEDERAL POWER COMMISSION
REGIONAL OFFICE
346 Broadway
New York 13, New York

July 13, 1962

District Engineer
U. S. Army District, Huntington
P. O. Box 2127
Huntington 18, West Virginia

Subject: Survey Report - White Oak Creek Basin, Ohio

Dear Sir:

Reference is made to your letter of May 23, 1962, addressed to our Chicago Regional Engineer requesting comments on the hydro-electric power potentialities of the White Oak Creek Reservoir, White Oak Creek, Ohio. Inasmuch as the above basin is within the jurisdictional area of the New York Regional Office, your letter was forwarded to this office for reply.

Pursuant to your request, there are set forth herein the results of our review of the power potentialities of the proposed White Oak Creek Reservoir Project. Our staff has investigated the possibilities of utilizing the proposed White Oak Creek Reservoir for power development under two alternative plans as described in the following:

Plan I

Under this plan, the permanent pool proposed by the District Engineer at elevation 805 would be drawn about 19 feet during critical winter flow period to provide about 18,000 acre-feet of usable storage and a minimum regulated flow of about 43 cfs. Continuous power would amount to about 340 kilowatts. Operating under an average net head of 113 feet, installed capacity would amount to 1,700 kilowatts capable of generating 8,800,000 kilowatt-hours of average annual energy.

The estimated cost chargeable to power, including power plant and equipment amounts to about $850,000. With associated annual charges based on federal financing, estimated at $75,500 (excluding taxes foregone) and annual power benefits at $58,000, the benefit-cost ratio is 0.77.

Plan II

Under this plan, the power pool would be raised to elevation 864 during the summer providing about 31,000 acre-feet of usable storage with a drawdown of 18 feet. During the winter months the top of the power pool would be at elevation 854 providing the same power storage with a drawdown of 24 feet to elevation 830. The loss of flood control storage capacity resulting thereby would be replaced by equivalent controlled surcharge storage. This would require the installation of spillway gates and lengthening of the spillway to maintain the design discharge capacity. The project would be operated so as not to exceed the proposed maximum flood control pool elevation.

With a minimum regulated flow of 65 cfs and an average net head during winter months of 160 feet, continuous power would amount to about 730 kilowatts. Based on an installed capacity of 3,650 kilowatts, the average annual energy would aggregate about 19,000,000 kilowatt-hours.

The estimated cost chargeable to power, including power plant and equipment, spillway gates and piers, spillway lengthening, and penstock amounts to about $6,250,000. Annual costs based on federal financing, excluding taxes foregone, are estimated at $309,000 and annual benefits at $126,000, resulting in a benefit-cost ratio of 0.41.

In view of the unfavorable results of our staff studies, it is concluded that provisions for the possible future development of hydroelectric power at the proposed White Oak Creek Reservoir Project would not be justified.

Sincerely yours,

D J Wait

D. J. Wait
Regional Engineer

Sheet 2 of 2
EXHIBIT 14-28

In addition to the above, Public Law 89-655, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

26. STATE AGENCIES

Coordination has been maintained throughout the course of these studies with the Ohio Department of Natural Resources and its various Divisions. The Department **has** been an active participant, particularly in developing plans for general recreation and in evolving a plan for the Wildlife Management Unit, which includes the inviolate migratory waterfowl refuge.

As a result of a series of meetings and discussions regarding the formulation of plans for the Whiteoak Dam and Reservoir, the Director of the Department of Natural Resources submitted a letter to the Huntington District of the Corps of Engineers on 31 January 1968. The Director, acting as the designated representative of the Governor in matters of mutual interest to the Corps of Engineers and the State of Ohio, submitted a preliminary land use plan, including the proposal for development of a goose and general waterfowl refuge, for consideration by the Corps of Engineers in cooperation with the U. S. Fish and Wildlife Service. The Director's letter of 31 January 1968 is included as Exhibit 14-29.

27. LOCAL GROUPS

Valuable assistance was provided during the course of these studies by local agencies and organizations, particularly by the Brown County Planning Commission. Interest in economic growth and in resolution of the local water supply deficiency has been expressed by the Planning Commission. This interest was reflected in the preparation of a Summary Comprehensive Plan for Brown County, in March 1965, under the Urban Planning Assistance Program.

JAMES A. RHODES
GOVERNOR

FRED E. MORR
DIRECTOR

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
OHIO DEPARTMENTS BUILDING
COLUMBUS 43215

January 31, 1968

Colonel William D. Falck
District Engineer
U. S. Army Engineer District, Huntington
Post Office Box 2127
Huntington, West Virginia 25721

Whiteoak Creek Reservoir-
Preliminary Land Use Plan

Dear Colonel Falck:

As the result of a conference held in Cincinnati on January 19, 1968 concerning the various project purposes of the proposed Whiteoak Creek Reservoir attended by members of your staff, Ohio River Division Office, U. S. Fish and Wildlife Service, U. S. Bureau of Outdoor Recreation, and members of my staff, we are furnishing a preliminary land use plan of the proposed project lands.

It is to be noted that 7,900 acres in the upper part of the project lands are to be used for fish and wildlife purposes with 5,150 acres of this area to be developed as a goose and general waterfowl refuge. The lower part of the project comprising about 5,200 acres is to be developed for general outdoor recreation.

Your consideration of these proposals in cooperation with the Fish and Wildlife Service would be appreciated.

Sincerely,

Fred E. Morr

FRED E. MORR
Director

FEM:bg
1 encl: Land Use Plan

ccs: Robert W. Burwell, Regional Director
Bureau of Sport Fisheries and Wildlife
1006 West Lake Street, Minneapolis, Minn. 55408

Roman H. Koenings, Regional Director
Bureau of Outdoor Recreation
3853 Research Park Drive,
Ann Arbor, Michigan 48104

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28. PUBLIC HEARINGS

Public hearings were held by the District Engineer, U. S. Army Engineer District, Huntington, on 14 June 1963 and 23 May 1968, at Georgetown, Ohio, for the purpose of determining the views and desires of local interests on development of the Whiteoak Creek Basin for water supply and allied purposes. The latter hearing presented the plans reported on herein. Approximately 130 people attended each hearing, including: a representative in Congress (at the first hearing only); one State representative; representatives of various Federal, State and local agencies; landowners and interested residents. Many formal resolutions in favor of the tentative proposals were submitted by various civic, religious, institutional and private organizations. The proponents expressed major concern for the economic redevelopment of the basin and for the development of adequate water supply for both urban and rural use. Opposition to the Whiteoak Reservoir was expressed primarily by several non-resident land-owners whose property would be within the reservoir area. Copies of the transcripts of the public hearings are available in the Huntington District Office, Corps of Engineers.

A list of local organizations submitting statements favoring the project follows:

Ohio Department of Natural Resources
Ohio Department of Health
Brown County Planning Commission
Area Redevelopment Council of Brown County
Ohio Valley Improvement Association
Brown County Airport Board of Authority
Council of the Village of Mt. Orab
Brown County Board of Commissioners
Board of Public Affairs of the Village of Georgetown
Council of the Village of Hamersville, Ohio
Board of Trustees of Public Affairs, Sardinia, Ohio
Washington Township Trustees
Council of the Village of Sardinia
Sardinia Chamber of Commerce
Brown County Board of Education
Mt. Orab Board of Public Affairs
Mt. Orab Community Chamber of Commerce

The Board of Trustees of Scott Township submitted a letter opposing the Whiteoak Reservoir project.

29. PROCEDURES FOR PLAN IMPLEMENTATION

Conversion to reality of the plan of development for the Whiteoak Dam and Reservoir Project, as proposed herein, will require close coordination between the Corps of Engineers and the Ohio Department of Natural Resources, and careful attention to sequencing of the various steps of the plan.

After authorization, detailed site investigation and design should be made for the purpose of accurately defining the project lands required. Subsequently, advance acquisition should be made of such title to such lands as may be required to preserve the site against incompatible development.

At the time of advance acquisition, a master plan for coordinated development of recreation facilities and of the migratory waterfowl refuge would be worked out with the Ohio Department of Natural Resources which would assume responsibility for operating and maintaining these developments. The master plan would include details of measures to prevent unnecessary despoilation or disturbance of the natural environment during construction, in addition to plans for reclaiming and beautifying construction areas. Advanced engineering and design would then continue through its normal course.

All land acquisition and construction would be the responsibility of the Corps of Engineers. Recreation facilities and the goose refuge would be turned over to the Ohio Department of Natural Resources for operation and maintenance in accordance with the master plan of development. The Corps would be responsible for operation and maintenance of the dam and reservoir.

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SECTION IX - DISCUSSION AND CONCLUSIONS

30. DISCUSSION

The studies for the Whiteoak Creek Basin, reported on herein, are in partial response to the Appalachian Regional Development Act of 1965 and in compliance with Senate Resolution adopted 10 September 1957 and House Resolution adopted 1 July 1958.

As a result of the broad-based screening and inventory studies and in view of the outstanding resolutions requesting survey scope investigation, the potential Whiteoak Dam and Reservoir project and Brown County, Ohio, were selected for detailed development analysis.

The economically optimum plan for Whiteoak Reservoir modified to incorporate the migratory goose refuge was selected as being most appropriate to the overall plan of development. The reservoir plan could be complemented by development of a comprehensive recreation development plan for the Whiteoak Creek Basin and Brown County. The recreation lake which has been proposed by the Soil Conservation Service as a part of its plan for the upper Whiteoak Creek watershed should be coordinated and planned to complement the Whiteoak Reservoir with its refuge. Viewed from the broader perspective of a complex of projects, the variety of usage and uniqueness offered by the refuge takes on a more significant value. It is mainly for this reason that inclusion of the refuge in the water project plan is considered to be desirable. The industrial, commercial and residential components of the developmental plan would blend harmoniously with such a complex.

Since the overall economic development plan would depend directly on the water supply function only of the water project and since the quantity requirements for water supply were established by extended benchmark projections, the water project could be isolated from the associated development plan and formulated independently. The resulting scope and scale of the Whiteoak Dam and Reservoir, therefore, can be considered the highest and best use of the available site to the extent that the associated economic development plan is successful in supplementing the water project to achieve the benchmark objectives reflected in the projections. The optimum project scale, then, was implicit in the assumption of the benchmark level of economic development and activity.

Quantification of the magnitude of the necessary investment and of the resulting economic return to the Nation and the Appalachian Region is, therefore, a matter of establishing the most efficient, effective and desirable means through which the assumed levels of

activity may be achieved. The associated economic development plan is presented in Part II as the most likely means and is considered both efficient and effective.

The development of the industrial, commercial and residential components of the plan would be carried out essentially by non-Federal interests.

As stated in the Appalachian Regional Development Act of 1965 (PL 89-4), the region lags behind the rest of the Nation in its economic growth and its people have not shared properly in the Nation's prosperity. The purpose of the Act, therefore, is to assist the region in meeting its special problems, to promote its economic development, and to establish a framework for joint Federal and State and local efforts toward providing the basic facilities essential to its growth. Since the area has lagged in its development, the fiscal base is inadequate, at this time, to permit the local interests to undertake the capital outlays necessary for the preparation of industrial sites. The realization of the potential benefits of the plan are dependent, to a large degree, on the initiative and vigor of non-Federal interests in attracting industry to the area. In order to assure that non-Federal (State or local) interests have the working tools for attracting industry, it is essential that a properly constituted public or quasi-public body, or bodies, be established, which should have the minimum authority to (1) exercise the right of eminent domain for developmental purposes, (2) issue bonds or have other revenue sources sufficient to assure orderly acquisition and development of necessary lands, (3) enter into contracts with the United States and the State of Ohio (if the body is not a political sub-body of the State), and (4) zone and control land use.

31. CONCLUSIONS

The comprehensive plan of development would allow efficient achievement of the goals of the Appalachian Regional Development Program as reflected by the performance indexes as well as by the traditional analysis of net benefits. The benchmark objectives would be reached with a substantial return to the Appalachian Region on the necessary investment. The Appalachian Regional Development Act makes the development of this region and the effective employment of its people an integral part of National economic policy. Thus, in effect, the return to the regional economic account can be considered as being in the National interest, if not specifically in the National economic account. The water resource plan will clearly induce considerable employment in an area of chronic and persistent unemployment, and will bring into the National economy factors of production that have stubbornly resisted inducement to move to employment centers. The water resource plan creates a new environment

for growth in a distressed part of Appalachia, and should stimulate new hope and creativity in the population.

It is concluded that both the Whiteoak Dam and Reservoir Project and the associated developmental plan for Brown County are needed to reach the developmental objectives for the area, and that the two components of the plan have been optimally scaled to derive maximum developmental response as well as to fulfill, to the extent possible, the assessed physical water resource needs. The recommended plan would be fully compatible with the overall Appalachian plan.

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

WHITEOAK DAM AND RESERVOIR PROJECT

WHITEOAK CREEK BASIN, OHIO

EXHIBIT 14-30

THE ECONOMY OF BROWN COUNTY, OHIO

THE ECONOMY OF BROWN COUNTY, OHIO

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Participation rates for Brown County are lower than the National average, especially for females. Of 8,900 females 14 years old or more, only 24 percent were listed in the labor force which contrasts sharply with the participation rate of 75 percent for males. Counties proximate to Brown County possess similar participation rates.

Increased participation rates, those currently unemployed, allowing for fractional and seasonal variations, and the number of underemployed (primarily low income farm operators) give the Brown County area a small surplus of available labor.

4. EMPLOYMENT

Employment in Brown County was 7,900 in 1960. The largest source of employment was agriculture which accounted for 27 percent of all jobs. The second largest source, comprising 26 percent of total employment, was manufacturing which increased 65 percent from the 1950 level. It is estimated that 75 percent of the county's manufacturing employment represents workers who commute to the Cincinnati metropolitan area. Only one manufacturing concern of any significant size is located in Brown County. Employment in wholesale and retail trade (1200) and in personal and business services (1100) is proportionally small in relation to total employment. The Cincinnati area, with its array of commercial enterprises offers a wider selection of goods and services than those that can be provided in Brown County. Recent increases in the number of jobs for Brown County residents result from the growth and expansion of the metropolitan area to the west.

5. INCOME AND OUTPUT

Median family income for Brown County in 1959 was $4103, an amount which is $2068 less than the state median. In 1962, the county's per capita income (measured in 1954 dollars) was estimated at $1380 compared to a National average of $2114 and an average of $1822 in Appalachia.

Value added by manufacturing decreased by 3.6 percent between the 1958 and the 1963 Census of Manufacturers. Agriculture is a major contributor to the counties output. Income from the sale of agricultural products was $1,000,000 in 1961. The largest single source of agricultural income was burley tobacco.

6. TRANSPORTATION

a. Highways. The Brown County area is served by four U. S. highways and several heavy duty state routes, as shown in Plate 1. Major improvements to many of these routes, including new four-lane construction, is either scheduled or planned. A major new four-lane highway along Appalachian Corridor D is proposed for construction through the

THE ECONOMY OF BROWN COUNTY, OHIO

SECTION I - EVALUATION OF THE PRESENT ECONOMY

1. POPULATION

According to an estimate by the Ohio Department of Development, the 1966 population of Brown County, which includes most of the Whiteoak Creek basin, was 27,000, an increase of seven percent over the 1960 census count of 25,200. The county was 11 percent urban. The population density of Brown County was 55 persons per square mile which is only one-fourth of the state's average density.

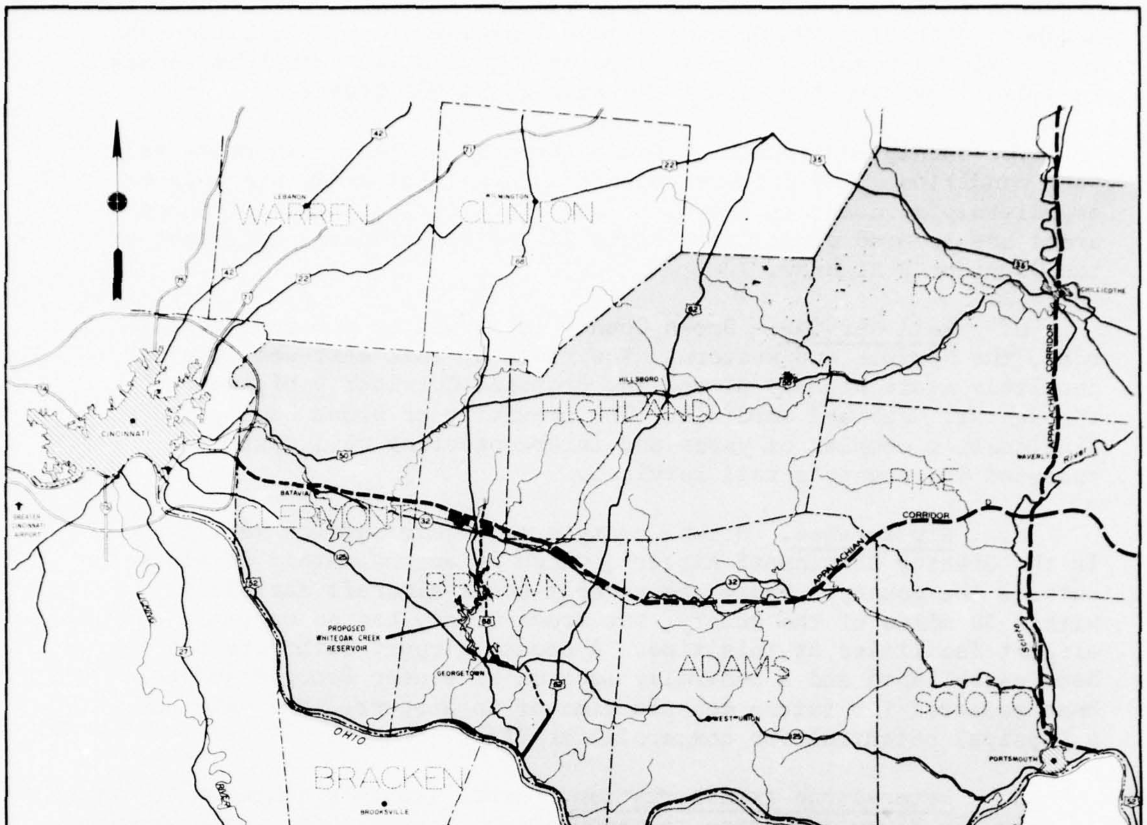
2. TOPOGRAPHY AND RESOURCES

Brown County has a varied topography with a maximum relief of 725 feet. While the northern portion of the county contains large tracts of level land, the southern portion is characterized by deep ravines and steep hills. Soil types are likewise varied since the county has some of the richest as well as some of the poorest soils in the State of Ohio.

The county has no significant mineral resources. Some limestone is quarried and gravel has been excavated recently from the Whiteoak Creek channel.

3. LABOR FORCE

In 1960, according to the Census Bureau, the labor force of Brown County was 8,700, up 10 percent from the 1950 level. Unemployment represented 5.7 percent of the labor force. According to the Ohio Bureau of Unemployment Compensation, Brown County's rate of unemployment in early 1967 was 4.6 percent of the total labor force. While the Census and the Bureau of Unemployment Compensation make computations from different data sources, the decrease in the unemployment rate indicates that Brown County is improving even though the current rate is still above the National rate. The major occupation groups of the unemployed in Brown County in 1960 were craftsmen, foremen, operative and kindred workers. They represented slightly more than 50 percent of all the unemployed.


WARREN
CLINTON
ROSS
HIGHLAND
PIKE
CLERMONT
BROWN
ADAMS
SCIOTO
BRACKEN
MASON
LEWIS
ROBERT-SON
FLEMING
CINCINNATI
HILLSBORO
BATAVIA
GEORGETOWN
WEST UNION
PORTSMOUTH
BROOKSVILLE
MAYSVILLE
VANCEBURG
MT. OLIVET
FLEMINGSBURG
OHIO
RIVER
APPALACHIAN CORRIDOR D
PROPOSED WHITEOAK CREEK RESERVOIR
LEGEND
APPALACHIAN REGION
PROPOSED AIRPORT
EXISTING AIRPORT
INTERSTATE HIGHWAYS (EXISTING AND PROPOSED)
EXISTING PRIMARY HIGHWAYS
PROPOSED APPALACHIAN CORRIDOR HIGHWAYS
COUNTY SEATS
PROPOSED INDUSTRIAL AREAS
SCALE IN MILES
BROWN COUNTY, OHIO
REGIONAL TRANSPORTATION NETWORK
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT-CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

northern part of Brown County. These improvements will provide the county with a complete system of major highways and excellent access to distant markets throughout the eastern United States.

The county and township road network is presently in relatively poor condition. The primary potential industrial areas are located immediately adjacent to the U. S. and state routes. Most of these areas are located along State Route 32 and the proposed alignment of the Corridor D Highway.

b. Rail service. Brown County is served by a mainline railroad, the Norfolk and Western. The route of this east-west carrier parallels state highway 32 and the proposed Corridor D Highway through Mt. Orab and Sardinia. The proximity of Brown County to Cincinnati's complex of yards and interconnecting rail systems enhances the county's rail service.

c. Air service. Brown County's major air service facility is the Greater Cincinnati Airport, which is approximately 60 miles outside the county. There are several small aircraft facilities within 30 miles of the county, but Brown County has no operable airport facilities at this time. A county airport authority has been established and a centrally located site near Georgetown has been selected for future construction of an airport. The site has a physical potential for commercial traffic.

d. Water-borne transportation. Brown County's southern border is the Ohio River and barge transportation is available. Rail service is not available along the river; consequently, significant industrial development has not materialized.

7. COMMUNITY ENVIRONMENT

a. Government. Brown County is governed by the Board of County Commissioners. The county contains ten incorporated municipalities of which Georgetown, the county seat, is the largest.

The county government derives revenue from property taxes, bonding, and state and Federal aid. Bonded indebtedness has recently been incurred by the county to finance renovation of its court house and improvement of recreation areas. Because of the legal bonded indebtedness limitations imposed by the state constitution, the remaining debt capacity is not sufficient to finance other major capital improvements.

b. Land development policies, codes and ordinances. Proposed codes for zoning and subdivisions are being considered by the county as a part of the current master plan. No codes or ordinances have been established at this time. The importance of adequate land use planning

in attaining the objectives of the economic development plan is discussed subsequently in Section II.

c. Fire and police protection. Fire protection throughout the county is provided by volunteer fire departments. Substantial areas of the county lie outside the recommended radius of five miles from a fire station. Provision of dependable water supplies and improvement of the county road network would increase the limited capability of the existing departments.

Police protection and law enforcement are provided by the county sheriff and his staff, by state police and by small municipal forces.

d. Health facilities. There is one general hospital in Brown County. The 125-bed hospital, located in Georgetown, also serves Clermont, Highland, and Adams Counties in Ohio as well as parts of northern Kentucky. Consideration is currently being given to locating a state mental health facility in the vicinity of the existing hospital.

e. Recreation facilities. A detailed analysis of the outdoor recreation potential of the proposed Whiteoak Reservoir is contained in Appendix F. The development of this major recreation facility could have a major impact on the economy of Brown County. The prospective influx of visitors and the associated commercial development will require careful land use planning and zoning to protect prime industrial and residential areas.

f. Educational facilities. Brown County has six public school districts, one exempted school district, and two parochial schools. Although the school facilities are generally adequate, financing for operation and maintenance has become increasingly difficult.

Vocational training is offered in all high schools, but there are no specialized vocational training schools. The State of Ohio has proposed a $1,500,000 vocational training school to serve a five-county area. A site in Brown County has been recommended for this facility.

In 1968, a branch college of the University of Cincinnati is expected to be instituted in Brown County. Two-year curricula in liberal arts and business will be available in addition to specialized training in farm management.

g. Utilities. All incorporated villages in Brown County have municipal water systems. The unreliable supply of water frequently is cause for concern in these villages. The problem is more crucial in rural areas where supplies may fluctuate more than in the villages. Underground supplies are very limited. Generally, wells must be supplemented by cisterns to provide sufficient water for domestic use.

Georgetown is the only community with a storm sewer system. Most of the incorporated villages have completed sanitary sewer systems or are in the process of doing so with Federal or state assistance. In most areas of the county, individual septic systems are used. The greatest health hazard occurs in unincorporated communities which rely on systems which may not be adequately designed.

Electrical and telephone services are extended to Brown County through private utility companies. Natural gas will be extended this year. Most of the county is provided with electric power by the Cincinnati Gas & Electric Company. Other electric service within the county is supplied by Hillsboro Rural Electric Association, whose lines supply mostly single-phase power to rural areas near Mt. Orab, and by Columbus and Southern Ohio Electric Company, serving Aberdeen, Sardinia, and portions of four eastern townships.

8. EVALUATION

Typical Appalachian conditions, low income and high unemployment, are evident in Brown County. These conditions are attributed to low labor force participation and level of education. The median school year completed by adults is two full years less than the state median. The participation rate of females in the labor force is well below the state average. A measure of male underemployment can be recognized in the high percentage of farmers with low income.

The existing pattern of slow growth with income and employment well below the state average will probably continue unless efforts are made to encourage economic growth. Evaluation of future prospects with and without a special Appalachian program is discussed in Section II.

Existing public and private facilities can provide some of the services required to sustain economic growth and can be expanded to meet developing demands for services.

SECTION II - ECONOMIC POTENTIAL

9. RESTRAINTS TO GROWTH

There are several reasons why Brown County inhabitants have low income and significant underemployment.

The largest sector of employment is agriculture. This sector has been declining and will continue to decline. Many of the farms are efficient enterprises; others are small and inefficient and continue in production because of the lack of opportunity for employment elsewhere.

The industrial base is small and opportunities for local employment are limited. Commuting to the Cincinnati area provides employment opportunities, but the distance involved is a restraint. Some people prefer not to drive the 60-80 miles daily.

Tourist attractions and facilities are somewhat limited and income from this source is low. Timber and mineral resources provide almost no employment and prospects for development are slight.

The water supply is inadequate in most of the county. This is a restraint that must be removed if growth is to be realized. The only dependable major source that could be developed economically would be a reservoir on the main stem of Whiteoak Creek. Preliminary studies indicated that the watershed would be capable of furnishing a dependable water supply for a maximum population of about 200,000.

10. INDUSTRIAL DEVELOPMENT OPPORTUNITIES

a. Location advantages. Industries in the Brown County area would have a favorable relationship to markets quite similar to that enjoyed by Cincinnati. Five metropolitan areas are within two hours travel time by truck. Cleveland and Chicago are within one day travel, and second day deliveries can be made to such major market areas as Atlanta and Charlotte. The primary highway system is good, and with improvements and proposed relocations, will be excellent. Construction of Appalachian Corridor D will greatly reduce travel time to the east and will also provide direct access to good industrial sites in Brown County. Cincinnati would be 35-40 miles away by this modern 4-lane limited access highway. The interstate road system at nearby Cincinnati provides excellent access to points north, south, or west. A mainline of the Norfolk and Western railroad parallels the proposed Corridor D highway. Rail service can be economically provided for industries desiring this service.

The State of Ohio has a program of revenue bond financing whereby local communities can obtain low-cost financing of land, building, machinery, and equipment for new or expanding industry. A program of this type definitely increases prospects of attracting new industries. Some industrial corporations favor this method of financing because of the low cost.

The underemployment of rural males, the low participation rate of females in the labor force, and the active unemployed represent a labor reserve that can be used advantageously by industry.

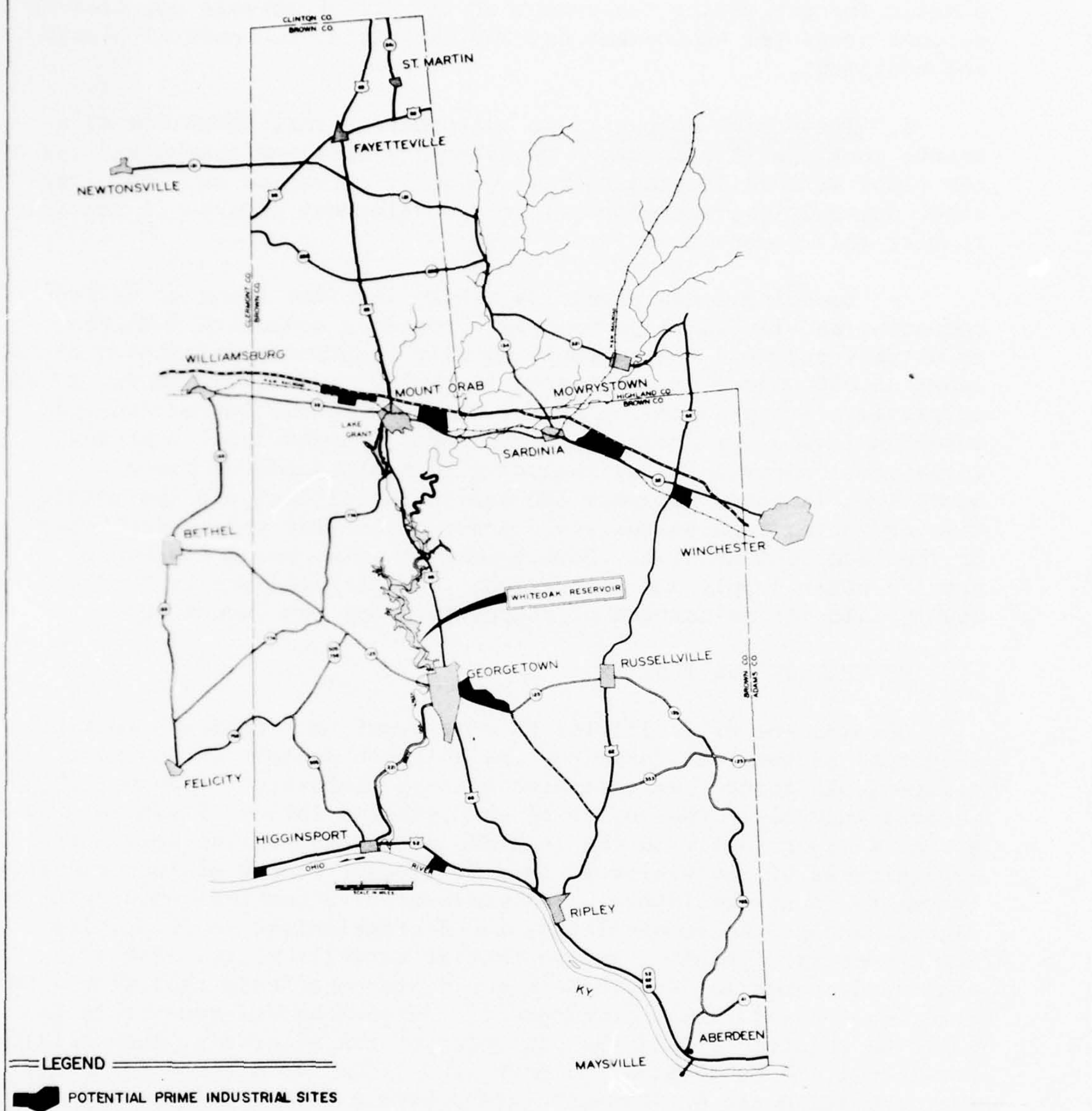
With development of a reservoir and a plentiful supply of water, dependable water and sewer service can be extended to industrial locations. Electric power, natural gas, and telephone service are available. Thus, complete utility service for industry can be provided.

The availability of large tracts of flat land along the railroad and main highways represents a very definite advantage. South and east of Brown County, topography limits the amount of developable land. Although some prime sites between the highway and the railroad are disappearing due to residential encroachments, large acreages remain available.

The direct access to an excellent transportation network, as improved by Corridor D, will have the effect of upgrading tracts of farm land to excellent industrial sites. Plate 2 indicates, in general, the potential industrial areas. More than sufficient land is available for the commercial, residential, and public development anticipated in the development plan.

b. Site analyses. The large amount of land suitable for commercial and industrial expansion eliminates the necessity for detailed analysis of sites. Excellent plant sites are located along paved highways and the railroad. However, the better, or prime, industrial sites may be pre-empted for non-industrial purposes unless protective measures are taken. Since the available industrial areas have ground slopes generally under two percent, site preparation would be minimized. Natural drainage is relatively good, considering the flatness of the topography. Construction of access roads, if necessary, would incur low costs.

c. Industry identification. Industry is attracted to a particular location because the advantages offered by the location meet many of the plant's requirements. Brown County can meet the locational needs of various types of industries. The area is not particularly suitable for industries having significant amounts of waste or requiring large



BROWN COUNTY, OHIO

POTENTIAL PRIME INDUSTRIAL SITES

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

amounts of water. A wide array of industries was selected for study with larger employment assumed for those that have been identified as having growth potential. The industrial mix was developed to provide a basis for estimating the amount of industrial acreage required to support projected employment and for estimating the cost of plants and equipment.

d. Industrial competition. Determining that Brown County's assets meet specific industry requirements does not guarantee that a new plant will be located there. Competition can be expected from other communities; therefore, a good development program is required to meet this competition.

Locating a new plant frequently involves transfer of key operating and technical personnel. Providing community amenities to attract and hold these people usually requires a population of at least 15,000 unless an urban area is nearby. In Brown County, urban attractions are provided by nearby Cincinnati; the attractions of suburban living are provided in the local communities. Improved educational opportunities, including high standards of basic education; improved highways and health facilities; and the institution of zoning regulations would greatly increase the desirability of the local communities. Development of water resources would provide water supply and recreation. The package thrusts Brown County into the mainstream of competition for new industries.

11. RECREATION AND TOURISM

Development of facilities to complement the inherent recreation potential of the lake formed by the Whiteoak project including wildlife refuge would attract an estimated average visitation of about 700,000 persons annually. The impact of the seasonal influx of visitors would become a major factor in the economic evaluation of the area. The expenditures of the visitors would be a major source of supplementary income to county residents. Tax evaluations undoubtedly would increase significantly. Accommodation of the recreationists would involve new commercial, lodging, and restaurant establishments. Random, unplanned commercial development could pre-empt lands that should be reserved for industrial development. While a buffer zone of lands would be acquired around the perimeter of the reservoir, industrial, commercial and residential planning should be coordinated to insure that the aesthetic environment incorporating recreation development will be preserved. The long-range projections presented in the following section account for the new jobs in the services category and in the wholesale and retail trades category.

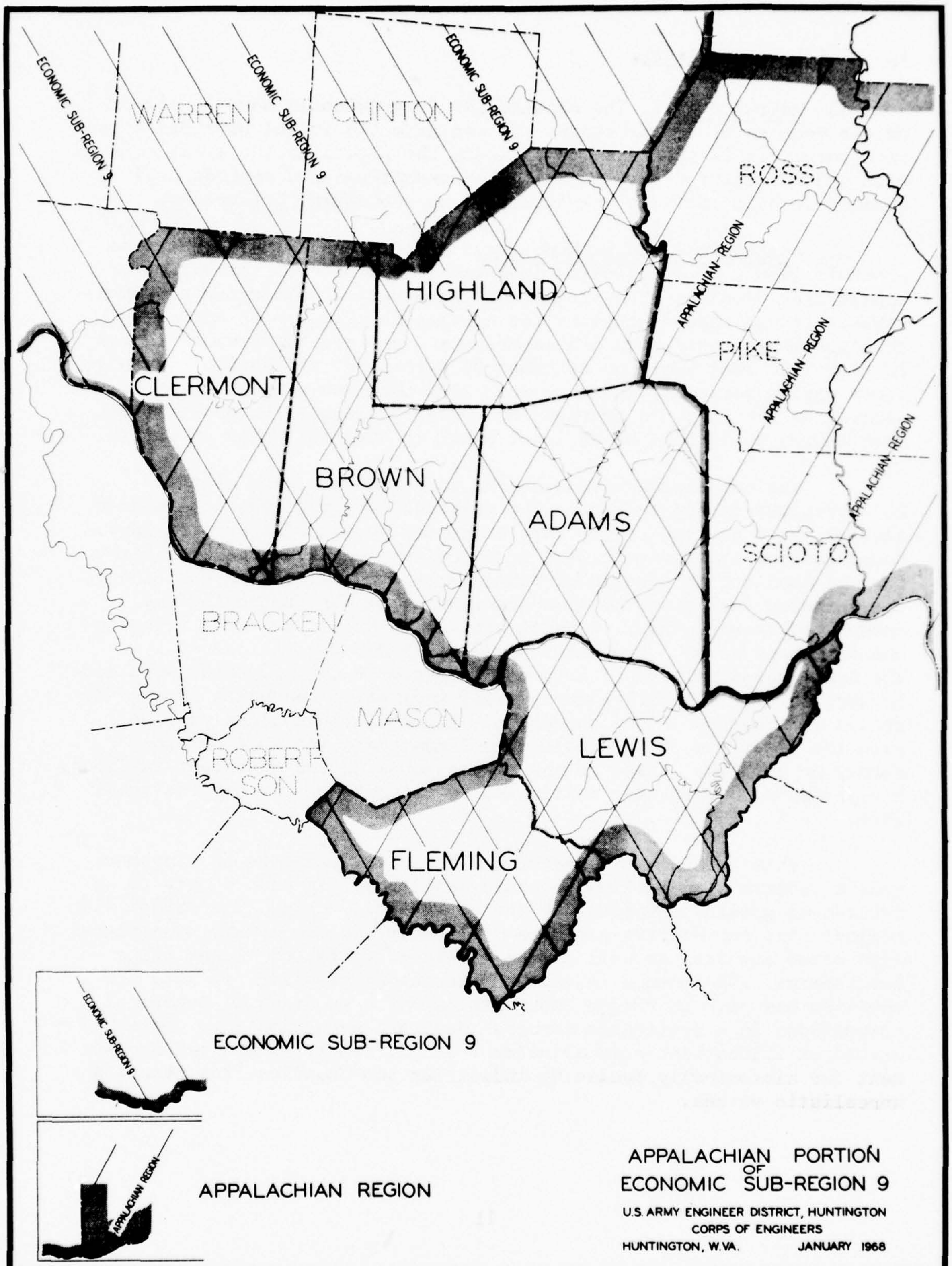
12. PROJECTIVE ANALYSIS

a. Introduction. The Appalachian Program could have an effect on the economy of Brown County. To evaluate the impact of Appalachian investment, it is necessary to estimate the growth of the local economy with and without the investment. The assumptions and methods used to conduct such an analysis are discussed in subsequent paragraphs.

b. Assumptions and methodology. Projections that indicate the probable impact of Appalachian investment were made by the Office of Appalachian Studies. The projections were termed developmental benchmarks. It was assumed that if the Appalachian Program is successful, the Appalachian economy would experience a per capita personal income in year 2000 that would be at least 90 percent of the Nation's average; a per capita personal income by year 2020 that would be at least 95 percent of the Nation's average; and rates of population growth from 1980 onward that would be at least equal to National rates of growth.

The developmental benchmarks were made for each of the 26 subregions of Appalachia. (The regionalization of the Appalachian economy was a portion of the work conducted by the Office of Business Economics for the Economic Base Study of Appalachia.) The benchmarks for the Appalachian portion of subregion 9, the sub-region containing the Whiteoak Basin, served as a starting point for projecting the economy of Brown County. Several methods of projecting were tried and are discussed below. Benchmark projections for the six counties in the Appalachian portion of economic subregion 9 (see Plate 3) were made by successively allocating the overall indices of benchmark growth to groups of counties in the subregion. Regression equations were used with the logarithm of time being the independent variable and the county or counties' share of the subregion being the dependent variable. The projected shares were multiplied by the projections for the total area.

This method was selected for the first estimate of benchmark growth because it permitted economic development in each county to be related to growth prospects for the region as a whole. The method also reflects the competitive position of industry in the county as compared with other counties as well as the growth potential of the existing development. The method is tailored to the availability of data for counties and also is simple enough to permit a substantial number of allocations in a systematic manner. However, even with this preferred method of allocation, some adjustment was necessary to prevent employment for historically declining industries and counties from reaching unrealistic values.



ECONOMIC SUB-REGION 9
ECONOMIC SUB-REGION 9
ECONOMIC SUB-REGION 9
WARREN
CLINTON
ROSS
HIGHLAND
APPALACHIAN REGION
PIKE
APPALACHIAN REGION
CLERMONT
BROWN
ADAMS
APPALACHIAN REGION
SCIOTO
BRACKEN
MASON
LEWIS
ROBERTSON
FLEMING
ECONOMIC SUB-REGION 9
ECONOMIC SUB-REGION 9
APPALACHIAN REGION
APPALACHIAN REGION
APPALACHIAN PORTION OF ECONOMIC SUB-REGION 9
U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

After projections were made using the method described above, an analysis of each county's projected economy was conducted. The analysis revealed that the projections for several counties were unsatisfactory. For example, Lewis County, Kentucky, emerged with a trend that, if continued, would empty the county, and Brown County, Ohio, in 2020 would have an abnormally high percentage of its total employment engaged in manufacturing. Therefore, a detailed examination of the area's "benchmark" economy became necessary.

The re-examination utilized data and information provided by the community and the State of Ohio. The economic and industrial potential of each county played an important part in the selection of final developmental benchmarks. Discussions with local planners and informed individuals and analysis of currently available employment and economic data provided insight permitting modification of rigid mathematical projections. Modifications were made where significant changes or departures were expected to result from the Appalachian investment.

It was assumed that the Whiteoak Reservoir and the Federal Developmental Highway Corridor D would represent developmental investment in subregion 9. Manufacturing employment was estimated on the basis of available plant sites. Other employment was distributed by assuming that each county would have a non-manufacturing mix similar to that of the parent region's developmental benchmarks. Population was projected by assuming population to be a function of employment.

Projections for each county that do not reflect the impact of the Appalachian program were made within a National projective framework of a high level of National employment and activity and no major depressions or wars. The "without" projections are an extension of past trends.

c. Limitations of projections. The estimates of future economic activity developed in this exhibit are based upon present knowledge of foreseeable developments and relationships of the past. The estimates were derived from a series of assumptions considered to be realistic and by extending past trends of development. If the assumptions do not materialize, then actual developments may differ significantly from those projected. The projections indicate one of a host of probable conditions that could occur in the area if the Appalachian investment occurs. Also, the reliability of the projections decreases as the size of the area being studied decreases. The reliability of the projections also decreases as the projection period expands. The projections should not be thought of as accurate or precise figures for exact years. They should be thought of as the magnitude and direction that may prevail under the assumptions used in this exhibit. The projections resulting from the assumptions and the methods described before are discussed hereinafter. The projections themselves are given in Tables I through IX.

TABLE I

EMPLOYMENT AND POPULATION DATA, ADAMS COUNTY, OHIO, NON-BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,429	3,443	1,893	1,100	700	600
Mining	21	41	34	30	40	30
Construction	218	328	443	400	400	500
Manufacturing	398	578	991	1,500	1,800	2,000
Transportation, Utilities, Communications	254	348	336	500	500	600
Trade, Wholesale & Retail	554	764	887	1,000	1,200	1,200
Finance, Insurance & Real Estate	53	81	124	200	200	200
Services, Personal & Business	666	658	841	1,100	1,300	1,600
Government & Armed Forces	140	167	188	300	400	400
Unreported Employment	66	268	182	-	-	-
Total	5,799	6,676	5,919	6,130	6,540	7,130
Population	21,705	20,499	19,982	19,500	19,000	18,000

* Non-Benchmark assumptions indicate the growth that could be expected in an area if the GNP grew at 4% a year in the absence of major wars and depressions.

TABLE II

EMPLOYMENT AND POPULATION DATA, ADAMS COUNTY, OHIO, BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,429	3,443	1,893	1,100	800	700
Mining	21	41	34	30	40	40
Construction	218	328	443 1/	400	500	600
Manufacturing	398	578	991	1,500	2,000	2,500
Transportation, Utilities, Communications	254	348	336	500 2/	600	700
Wholesale & Retail Trade	554	764	887	1,000	1,300	1,500
Finance, Insurance & Real Estate	53	81	124	200	200	300
Personal & Business Services	666	658	841	1,100	1,500	2,000
Government & Armed Forces	140	167	188	300	400	500
Unreported Employment	66	268	182	-	-	-
Total	5,799	6,676	5,919	6,130	7,340	8,840
Population	21,705	20,499	19,982	18,400	19,300	22,800

1/ 1000 construction workers by 1969 for J. M. Stuart Station

2/ Includes 70 employees for J. M. Stuart Station

* Benchmarks, as developed by the Office of Appalachian Studies, indicate what could happen if Appalachian investment occurs.

TABLE III

EMPLOYMENT AND POPULATION DATA, BROWN COUNTY, OHIO, NON-BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,836	3,441	2,104	1,300	500	500
Mining	8	18	0	0	0	0
Construction	364	430	546	700	500	600
Manufacturing	656	1,253	2,064	2,500	4,400	5,300
Transportation, Utilities, Communications	236	335	419	500	400	500
Trade, Wholesale & Retail	705	1,024	1,235	1,600	2,400	2,500
Finance, Insurance & Real Estate	84	100	187	300	200	300
Services, Personal & Business	754	819	1,097	3,000	3,700	4,600
Government & Armed Forces	139	178	248	300	300	400
Unreported Employment	92	128	336	-	-	-
Total	6,874	7,726	8,236	10,200	12,400	14,700
Population	21,638	22,221	25,178	28,000	33,600	37,800

* Non-Benchmark assumptions indicate the growth that could be expected in an area if the GNP grew at 4% a year in the absence of major wars and depressions.

TABLE IV

EMPLOYMENT AND POPULATION DATA, BROWN COUNTY, OHIO, BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,836	3,441	2,104	1,300	1,000	900
Mining	8	18	0	0	0	0
Construction	364	430	546	700	900	1,100
Manufacturing	656	1,253	2,064	2,500	8,400	10,400
Transportation, Communications, Utilities	236	335	419	500	800	1,000
Wholesale & Retail Trade	705	1,024	1,235	1,600	4,600	4,900
Finance, Insurance & Real Estate	84	100	187	300	400	500
Personal & Business Services	754	819	1,097	3,000	7,100	9,000
Government & Armed Forces	139	178	248	300	600	800
Unreported Employment	92	128	336	-	-	-
Total	6,874	7,726	8,236	10,200	23,800	28,600
Population	21,638	22,221	25,178	28,000	62,500	74,000

* Benchmarks, as developed by the Office of Appalachian Studies, indicate what could happen if Appalachian investment occurs.

TABLE V

EMPLOYMENT AND POPULATION DATA, CLERMONT COUNTY, OHIO, NON-BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,420	2,579	1,186	300	100	60
Mining	57	36	86	40	40	30
Construction	764	1,122	2,231	1,900	3,300	5,000
Manufacturing	2,488	4,375	10,697	13,400	14,800	15,400
Transportation, Communications, Utilities	583	960	1,992	1,700	1,900	1,900
Wholesale & Retail Trade	1,355	2,232	4,193	5,100	7,400	8,300
Finance, Insurance & Real Estate	216	353	820	2,100	3,000	3,700
Personal & Business Services	1,604	2,001	3,733	7,100	11,000	15,600
Government & Armed Forces	217	321	747	2,200	3,500	5,000
Unreported Employment	215	350	1,068	-	-	-
Total	10,919	14,329	26,753	33,840	45,040	54,990
Population	34,109	42,182	80,530	111,000	131,500	142,000

* Non-Benchmark Assumptions indicate the growth that could be expected in an area if the GNP grew at 4% a year in the absence of major wars and depressions

TABLE VI

EMPLOYMENT AND POPULATION DATA, CLERMONT COUNTY, OHIO, BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,420	2,579	1,186	400	200	100
Mining	57	36	86	50	50	50
Construction	764	1,122	2,231	2,300	4,800	8,400
Manufacturing	2,488	4,375	10,697	16,100	21,500	26,000
Transportation, Utilities, Communications	583	960	1,992	2,100	2,700	3,200
Wholesale & Retail Trade	1,355	2,232	4,193	6,200	10,700	14,000
Finance, Insurance & Real Estate	216	353	820	2,500	4,400	6,200
Personal & Business Services	1,604	2,001	3,733	8,600	16,000	26,300
Government & Armed Forces	217	321	747	2,700	5,100	8,500
Unreported Employment	215	350	1,068	-	-	-
Total	10,919	14,329	26,753	40,950	65,450	92,750
Population	34,109	42,182	80,530	117,000	172,000	239,000

* Benchmarks, as developed by the Office of Appalachian Studies, indicate what could happen if Appalachian investment occurs.

TABLE VII

EMPLOYMENT AND POPULATION DATA, HIGHLAND COUNTY, OHIO, NON-BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,536	3,514	2,281	1,800	1,500	1,300
Mining	53	90	53	20	20	20
Construction	431	526	667	800	1,000	1,200
Manufacturing	1,316	1,849	2,410	4,000	5,100	6,600
Transportation, Communications, Utilities	295	452	506	600	500	500
Wholesale & Retail Trade	1,244	1,596	1,785	2,200	2,300	2,300
Finance, Insurance & Real Estate	136	194	258	300	400	400
Personal & Business Services	1,236	1,382	1,735	2,600	2,800	2,800
Government & Armed Forces	175	310	380	500	500	500
Unreported Employment	125	216	313	-	-	-
Total	8,547	10,129	10,388	12,820	14,120	15,620
Population	27,099	28,188	29,716	33,500	37,300	41,000

* Non-Benchmark Assumptions indicate the growth that could be expected in an area if the GNP grew at 4% a year in the absence of major wars and depressions

TABLE VIII

EMPLOYMENT AND POPULATION DATA, HIGHLAND COUNTY, OHIO, BENCHMARK ASSUMPTIONS*

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	3,536	3,514	2,281	1,800	1,700	1,600
Mining	53	90	53	20	20	20
Construction	431	536	667	800	1,100	1,500
Manufacturing	1,316	1,849	2,410	4,000	5,600	8,400
Transportation, Utilities, Communications	295	452	506	600	600	700
Wholesale & Retail Trade	1,244	1,596	1,785	2,200	2,500	2,900
Finance, Insurance & Real Estate	136	194	258	300	400	500
Personal & Business Services	1,236	1,382	1,735	2,600	3,100	3,600
Government & Armed Forces	175	310	380	500	600	700
Unreported Employment	125	216	313	-	-	-
Total	8,547	10,129	10,388	12,820	15,620	19,920
Population	27,099	28,188	29,716	36,600	41,000	51,000

* Benchmarks, as developed by the Office of Appalachian Studies, indicate what could happen if Appalachian investment occurs.

TABLE IX

EMPLOYMENT AND POPULATION DATA, KENTUCKY PORTION OF OBE AREA 9 APPALACHIAN PORTION
SAME UNDER BENCHMARK OR NON-BENCHMARK

	1940	1950	1960	1980	2000	2020
Agriculture, Forestry, Fisheries	5,535	4,726	2,731	1,500	1,100	1,000
Mining	28	31	8	0	0	0
Construction	325	463	589	600	700	900
Manufacturing	640	565	1,219	3,800	6,400	8,000
Transportation, Communications, Utilities	339	392	269	300	400	500
Wholesale & Retail Trade	497	642	915	2,100	3,300	6,000
Finance, Insurance & Real Estate	40	62	101	200	300	400
Personal & Business Services	722	584	954	2,500	5,100	7,000
Government & Armed Forces	112	147	101	200	300	400
Unreported Employment	115	166	173	-	-	-
Total	8,358	7,778	7,060	11,200	17,600	24,200
Population	20,013	25,482	24,005	32,000	46,500	62,500

d. The general economy. If Appalachian investment does not occur in the Brown County area, it is anticipated that the economy will continue along paths that it experienced between 1930 and 1960. Growth in the area will be largely dependent upon job creation in the Cincinnati metropolitan area. There will be substantial out-commuting of jobs. Employment in agriculture would be expected to continue its decline, dropping to one-fourth of its 1960 level by 2020. Manufacturing employment would replace agriculture as the largest source of employment, accounting for 5,300, or 36 percent of total employment in 2020. Non-manufacturing jobs will expand, with the largest sectors being services and trade. Services will employ approximately 31 percent of total employment and trades will employ 17 percent. Brown County will still rely heavily upon the goods and services provided in the Cincinnati area. Population will increase 50 percent in 60 years from its 1960 level of 25,200.

If the Appalachia goals are achieved, the development of Brown County will be quite different. The developmental investment assumed to be necessary to enable Brown County to experience its fair share of the Nation's growth are the Whiteoak Reservoir and Appalachian Corridor D. The composition of the work force will change from one dominated by commuters to one dominated by non-commuters. The economy can be anticipated to continue as it has in the past until 1980 when the highway and reservoir become functional. Rapid growth will occur between 1980 and 2000 as the sites are developed and new plants locate in the area. Manufacturing employment will increase more than three times. Other employment sectors will expand due to the location of new plants. Commuting out of the county for manufacturing jobs will decrease to 33 percent of manufacturing jobs by the year 2000. Population will more than double. After 2000, the county will still continue to expand but at a lesser rate. Forty years after the completion of the highway and reservoir, employment will be three times larger than its present level with approximately 80 percent of the jobs existing in Brown County. Population will increase almost three times between 1960 and 2020. Although population will not increase as rapidly as the number of jobs, the utilization of the work force will be more efficient and participation rates and unemployment will be more in balance with the 2020 population.

The level of economic activities suggested by these projections indicate clearly that, with the new investment, the area will more fully participate in the Nation's growth. The cost of the investment and the measures that must be undertaken by all concerned parties are discussed in Exhibit 14-31.

13. CONCLUSIONS

Unlike most other counties within the Appalachian region, Brown County's development is not constrained by adverse topography. Most of the other location factors for industry are favorable. With a development program, remaining problems can be alleviated. The potential for growth is excellent. Any doubts about industrial preference for the general area can be disspelled by considering the amount and variety of existing industry in nearby Cincinnati.

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

WHITEOAK DAM AND RESERVOIR PROJECT

WHITEOAK CREEK BASIN, OHIO

EXHIBIT 14-31

FORMULATION OF THE INDUSTRIAL
DEVELOPMENT PLAN COMPONENT

FORMULATION OF THE INDUSTRIAL
DEVELOPMENT PLAN COMPONENT

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FORMULATION OF THE INDUSTRIAL
DEVELOPMENT PLAN COMPONENT

1. THE DEVELOPMENT PLAN

The special effort to help counties in Appalachia approach National levels of prosperity could have a significant impact on Brown County. Local, state, and Federal cooperation could cause a broad-ranged plan to be evolved. The successful execution of a developmental resource plan requires coordination between water resources, transportation, education, health, recreation, and other programs. Such a plan, when implemented, would have good prospects for increasing economic activity in Brown County.

The primary purpose of the developmental plan is to increase income by helping local people become more productive. Higher incomes are associated with vigorous economic activity. Employment of Brown County residents in the Cincinnati metropolitan area and in agriculture or other local endeavors does not provide adequate income for the Brown County area. New products or services would raise the level of export-import activity thereby generating higher income for area residents. The resources that are most susceptible to additional development include water and land for recreation facilities, industrial plants and ancillary commercial and residential development. Demand for outdoor recreation is created by nearby urban areas. While recreation will produce some new income, industrial development is the chief means through which a stable, prosperous economy can be achieved.

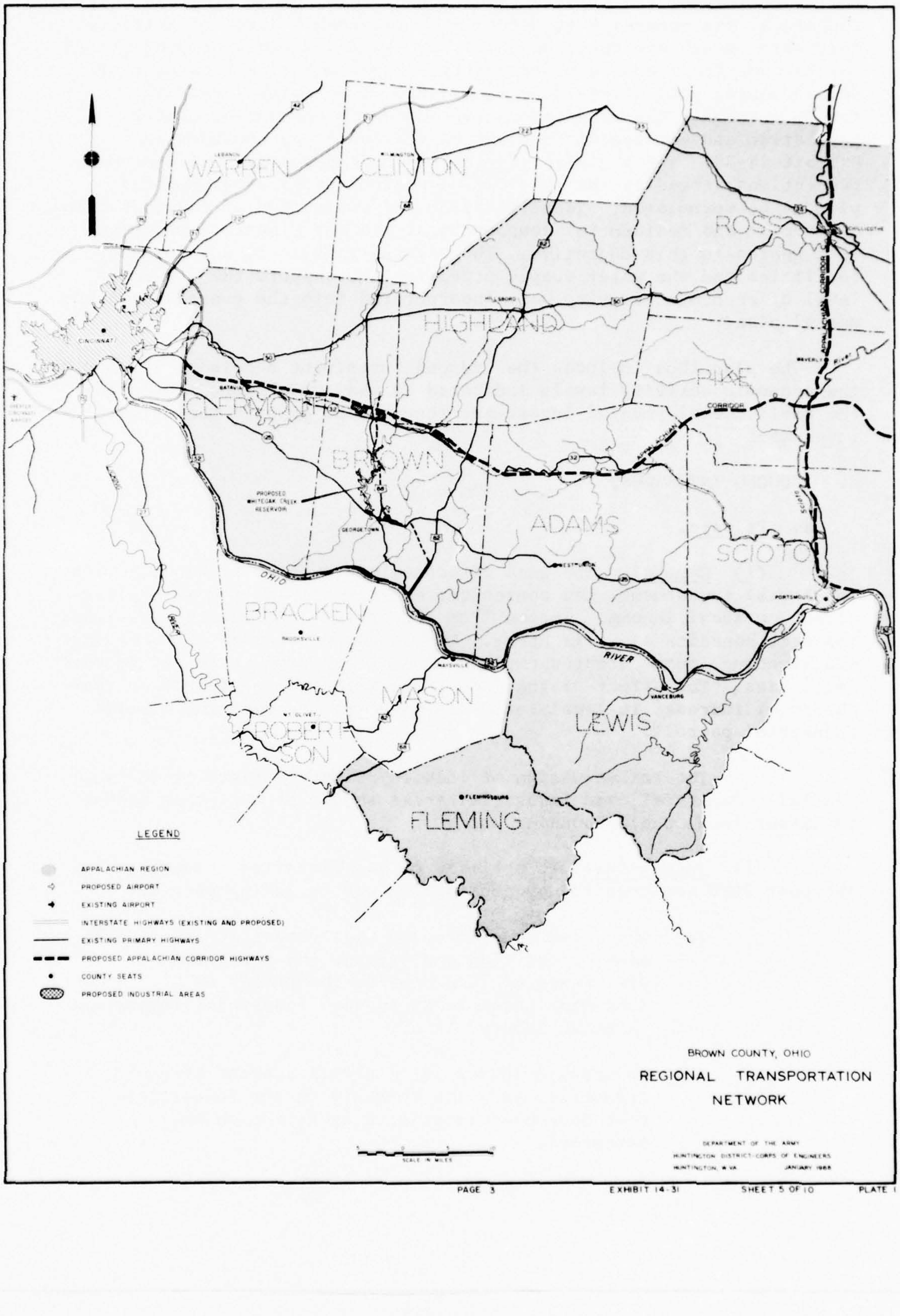
Without a dependable source of water, prospects for industrial expansion in Brown County are not good. The attendant residential and commercial growth cannot be supported by present water supply sources. A surprising number of local water shortages now exist throughout the county and the number is gradually increasing. These factors, coupled with emerging indications that great emphasis will be placed upon industrial expansion in rural areas to ease urban growth crises, indicate necessity for and importance of a long range water supply plan for Brown County. Should such a plan be available through intensive development of presently undependable water sources, then Brown County's competitive stature would be greatly enhanced.

A multiple purpose reservoir on Whiteoak Creek could provide a large and dependable water supply source for domestic and industrial purposes, thereby dissolving a major restraint to economic growth and complementing and strengthening the positive growth factors now at work.

The geographic location of Brown County with respect to markets and sources of materials is favorable for many different types of industries. The regional transportation network (existing and proposed) provides excellent access to markets and to sources of supply and is a major asset for attracting market-oriented industries. The network is shown on Plate 1.

The ideal location of the proposed Appalachian Corridor D developmental highway, near the railroad but far enough away so that the flat land between can be developed, presented a prime factor in developing an industrial development plan to be incorporated into an overall developmental plan. Rail spurs and highway access to industries in this area could be provided at very slight cost. Industry recognizes the advertising value of locating plants along major highways. The extensive amount of such desirable land in Brown County is not duplicated in other areas along the Corridor D highway. Thus, comprehensive plan of development for Brown County was formulated, based on (1) existing land-use patterns and trends; (2) the existing and proposed transportation network; (3) the industrial potential along the Corridor D highway, the Norfolk and Western Railway and Ohio Route 32; (4) the location of potential water resources development; (5) the external influences of the expanding Cincinnati metropolitan area on residential land use; (6) provision of public open-space areas; (7) intensive recreation development potentials allied to the water resources projects; (8) preservation and enhancement of the aesthetic quality of the potential recreation and open-space areas as well as of the residential areas; (9) the major highway network plan; and (10) the quantities of land necessary to support the projected industrial, commercial and residential needs. The developmental land-use plan also incorporated an earlier land-use plan prepared for Brown County near the Urban Planning Assistance Program authorized by Section 701 of the Housing Act of 1954. Whereas the earlier plan was intended to carry the County through 1980, the land-use plan formulated herein is designed to provide for the level of development projected for the year 2020 based on the attainment of the objectives of the total developmental plan. Therefore, it was necessary to quantify the 2020 level of development before the developmental land-use plan could be completed.

The potential Whiteoak multiple purpose reservoir project would provide a wide range of water supply capability. This capability and the positive forces which would create a healthy climate for economic growth indicated that greatly varying levels of economic activity could be achieved by the year 2020; even beyond that necessary to achieve



WARREN
CLINTON
ROSS
CHILLICOTHE
HIGHLAND
HILLSBORO
CINCINNATI
PIKE
CLERMONT
BATAVIA
BROWN
PROPOSED WHITEOAK CREEK RESERVOIR
GEORGETOWN
ADAMS
WEST UNION
SCIOTO
PORTSMOUTH
OHIO
RIVER
BRACKEN
BROOKSVILLE
MAYSVILLE
MASON
VANCEBURG
LEWIS
MT. OLIVET
ROBERT-SON
FLEMINGSBURG
FLEMING
CORRIDOR
LEGEND
APPALACHIAN REGION
PROPOSED AIRPORT
EXISTING AIRPORT
INTERSTATE HIGHWAYS (EXISTING AND PROPOSED)
EXISTING PRIMARY HIGHWAYS
PROPOSED APPALACHIAN CORRIDOR HIGHWAYS
COUNTY SEATS
PROPOSED INDUSTRIAL AREAS
SCALE IN MILES
BROWN COUNTY, OHIO
REGIONAL TRANSPORTATION NETWORK
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

the objectives of the Appalachian Regional Development Programs. It, therefore, was necessary to determine a reasonable level of activity necessary to achieve these objectives. The development of projections for the pertinent economic indicators, assuming full achievement of developmental goals, provided the measure of activity levels in tangible terms. The projections for benchmark and non-benchmark population and employment by place of residence are included in Exhibit 14-30. The activity suggested by the developmental benchmark projections served as the specific objective of the developmental plan to be formulated. Identification and evaluation of the industrial, commercial and residential components of the anticipated development were geared to this objective. The necessary physical development facilities and the water supply provisions to support the projected level of economic activity were incorporated into the overall developmental plan.

The plan thus includes the induced investment necessary to support the economic activity levels indicated by the projections, including the public developmental investment required to support the private investment.

2. INDUCED INVESTMENT

a. Private.

(1) General. The goal of economic growth is attainable with industrial investment, the consequent employment, and its multiplier effect on local income. Income from industrial jobs causes additional indirect benefits as it is spent. The subsequent rounds of receiving and spending income creates employment in local production and service facilities. The effect of the industrial wages is multiplied so that the total increase in local income is much greater than the initial industrial payroll.

The tax valuation of induced private investment in residential, commercial, and industrial areas should be more than enough to offset local public bonding costs.

(2) Industrial. An estimate of manufacturing investment in the year 2020 was prepared by considering the following points:

(a) Projected manufacturing employment with the development plan and without the plan, the difference of 14,600 being the number of jobs made possible by induced industrial investment in Brown County.

(b) An assumed industrial mix with a broad array of industries and with emphasis on the industries that have been identified as having growth potential.

(c) Industrial characteristics, such as average employment requirements, size of plant sites, site development costs, and plant and equipment costs.

This information was used as a basis for estimating total investment cost. Table I shows the induced industrial investment costs anticipated by the year 2020 in ten year intervals. Site development includes land cost; on-site grading, paving, utilities, and landscaping; and off-site capital investment in private utilities. Acreage required for industrial purposes probably would not exceed one-fifth acre per employee. At this rate, the maximum acreage required for the projected increase in industrial building would be 1140 acres.

(3) Commercial. The retail and service space requirements are based on the estimated dollar volume of sales generated by the additional population projected for the Brown County area. The per capita sales were related to per capita commercial floor space. Criteria for commercial development and typical costs were assumed to be as follows:

(a) A requirement of 62 square feet per capita of commercial space. (Reduce by 20 percent due to Cincinnati attracting a portion of commercial trade) -- Use 50 sq. ft./capita.

(b) Typical floor area of new shopping centers covers about 20 percent of the land area.

(c) Complete shopping center cost of $147,500 per acre.

The projected additional population in the area due to the development plan was projected to be 36,200.

36,200 x 50	= 1,810,000 sq. ft. of floor space
1,810,000 x 5	= 9,050,000 sq. ft. of land
	= 208 acres of land

An investment cost of $147,500 per acre multiplied by 208 acres produces a total of $30,680,000 of potential new investment in commercial development by 2020 in Brown County. Commercial investment per decade is shown in Table I.

(4) Residential. The projected population for 2020 creates no problems relative to space or land requirements. Construction of Whiteoak Reservoir removes the primary deterrent to growth by providing a dependable water supply. Expansion would probably take place around

TABLE I

INDUSTRIAL AND COMMERCIAL INVESTMENTS
BY DECADES

	1970-1980	1980-1990	1990-2000	2000-2010	2010-2020	TOTAL
Industrial Land and Site Development	$ 56,000	$ 606,000	$ 658,000	$ 196,000	$ 124,000	$ 1,640,000
Industrial Building and Equipment	1,829,000	38,147,000	68,072,000	23,328,000	20,385,000	151,761,000
Total Industrial Investment	$1,885,000	$38,753,000	$68,730,000	$23,524,000	$20,509,000	$153,401,000
Commercial Development		$12,245,000	$12,245,000	$ 3,095,000	$ 3,095,000	$ 30,680,000
						$184,081,000

existing population centers. It was not necessary for the purpose of establishing investment cost to identify areas of development. Residential criteria and typical costs were assumed to be as follows:

Multiple-family units equal 20 percent of total households.
Multiple-family units average 2.5 persons per household.
Single-family units average 3.5 persons per household.
Multiple-family unit requires average investment of
$9,600 per unit.
Single-family unit requires average investment of
$21,000 per unit.
(Includes land and improvement cost of $3,350 per unit.)

Combining the listed factors and costs produces a per capita housing cost of $5680. This investment includes land cost, total development cost, and structure cost. The projected population increase of 36,200 multiplied by $5680 produces a total investment of $205,616,000 by 2020 in residential development. The minimum land requirement would be about 1360 acres.

b. Public

(1) General. Projected growth with the development plan requires substantially more public investment than projected growth without the plan. This difference in the public investment due to the development plan was evaluated at the level required in the year 2020. Areas of public investment that were considered include schools, health facilities, fire protection, local recreation facilities, sewer and water facilities, and highways. The cost estimates were derived through formulae based on population. Therefore, a detailed layout to determine quantities was not necessary.

(2) Schools. The school expansion required to meet the needs of projected residential development was based on students per dwelling, 1960 census data. The figure was increased to reflect a higher percentage of high school attendance in 2020.

School	Students per Dwelling
Elementary	0.60
High School	0.26

With a projected population difference of 36,200 by 2020 and an average 3.3 persons per dwelling, facilities will be required to accommodate 6580 more elementary students and 2850 more high school students. Applying estimated cost of $1030 per elementary student and $1660 per high school student produces a total construction cost of $11,500,000.

(3) Health facilities. The population gain attributable to the development plan will require investment in hospital facilities. Serving a 2020 population increase of 36,200 at a standard of 14-beds per 1000 persons with a construction cost of $27,000 per bed requires an investment of $13,700,000.

(4) Fire protection facilities. The additional population to be served will require 5 two-bay, two-rig fire stations. Constructing and outfitting such a station will cost about $72,500. Total cost would be $362,500.

(5) Recreation facilities. A standard of one acre per 100 population was used to determine land requirements for local and neighborhood recreation facilities. The amount of land involved would be 362 acres. Total cost of land and facilities, at an estimated cost of $4200 per acre, would be $1,520,400. An additional investment in an 18-hole golf course would cost about $375,000. Total investment for local recreation purposes would be about $1,900,000.

(6) Water and sewer systems. The additional industrial development with 5700 employees and the increased population of 36,200 will require an investment in water and sewer facilities. A rate of 150 gpd per capita for residents, plus 300 gpd per industrial employee, creates a water demand of 7,150,000 gpd in 2020. The water distribution system, the sewage collection system and the respective treatment plants can be constructed at a cost estimated to be $9,652,500.

(7) Highways. The construction of Appalachian Corridor D highway places Brown County on an excellent east-west route connecting Cincinnati and the Washington-Baltimore metropolitan complex. Prospects of inducing industrial development are greatly increased by the construction of this highway. Although the cost of this highway is not an induced investment, the highway is considered necessary to attract investment and the cost of the highway within the boundaries of Brown County, $9,695,000, is charged to the development plan.

Existing county and township local roads total 675 miles including 220 miles paved. By assuming a higher rate of construction and repaving due to the larger population, it was possible to estimate local road expenditures without making a detailed plan. The greatly increased population, with development, will require additional paving of local roads; an estimated 230 miles of new paving and 130 miles of repaving. Total expenditure for constructing these roads was estimated to be $7,550,000 by the year 2020, making a total highway cost of $17,245,000.

c. Summary of developmental investment cost. The estimated total cost of the development that will provide the jobs and support the projected increase in population by the year 2020 is summarized in Table II. The cost of constructing Whiteoak Reservoir and recreation facilities at the reservoir have not been included.

TABLE II

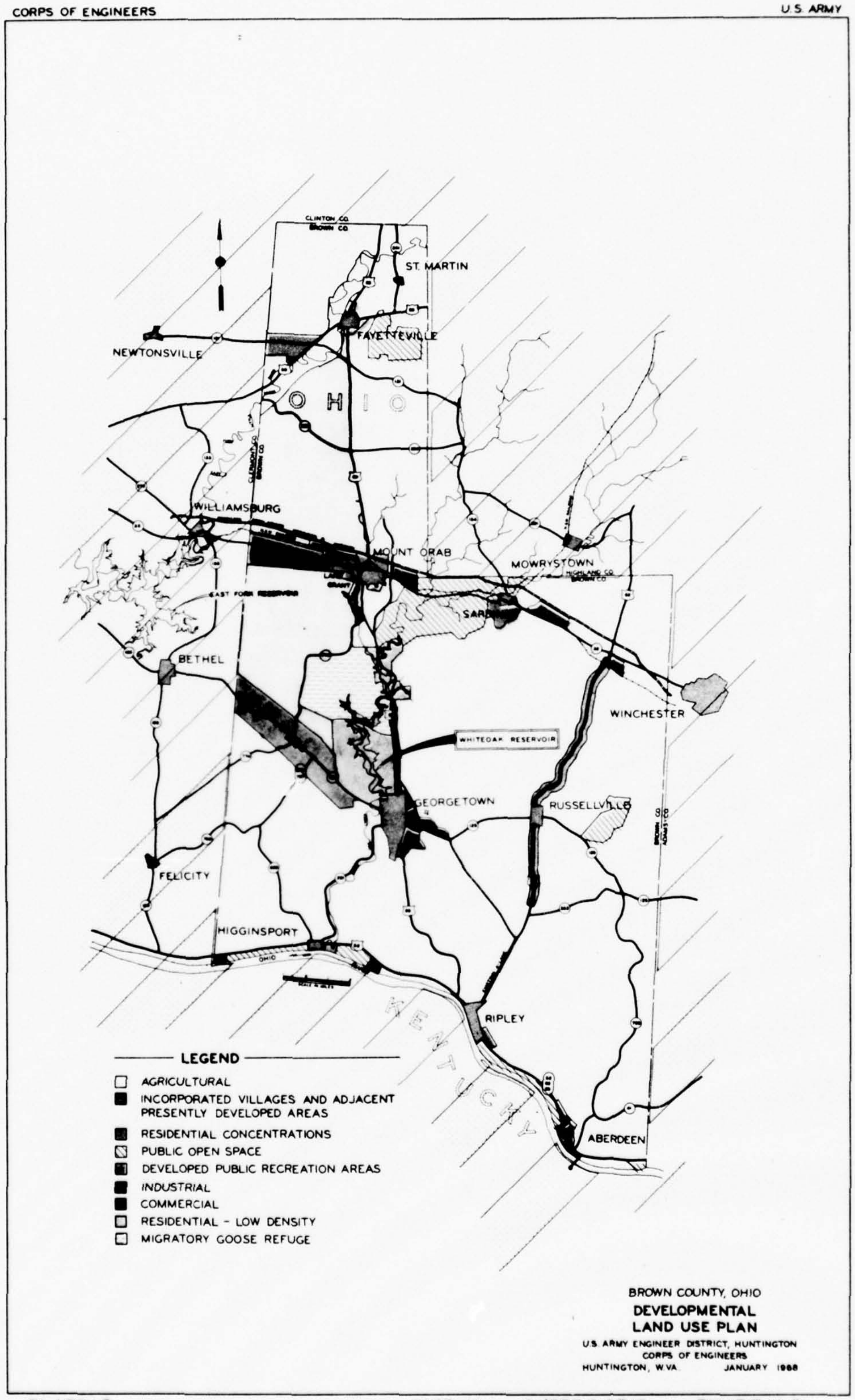
DEVELOPMENT PLAN INVESTMENT COSTS
AND ANNUAL CHARGES ($1,000)
WHITEOAK CREEK, OHIO
PLAN B-WITH THE REFUGE

Sector	Federal	Non-Federal	Total
Total Investment (1975-2025)			
Industrial and commercial	-	$ 184,081	$184,081
Commercial 1/	-	1,520	1,520
Residential	-	205,616	205,616
Public facilities	$26,979	27,381	54,360
Totals	$26,979	$ 418,598	$445,577
Annual Charges			
Industrial and commercial	-	$ 7,145	$ 7,145
Commercial 1/	-	112	112
Residential	-	6,315	6,315
Public facilities	$ 689	934	1,623
Totals	$ 689	$ 14,506	$ 15,195

1/ Private investment to support developmental effects of recreation visitor expenditures and respending of redevelopment wages for reservoir project with refuge.

3. THE RESULTING DEVELOPMENTAL LAND USE PLAN

With the projected physical development for the year 2020 quantified, the developmental land use plan was completed and is shown on Plate 2. Its importance is two-fold. The plan shows that the various proposed usages are compatible and provides a basis for more detailed planning including comprehensive zoning to insure preservation of individual areas for their specified use. The primary industrial sites in the Mount Orab and Sardinia area along Corridor D are shown at a larger scale on Plate 3.


CLINTON CO.
BROWN CO.
ST. MARTIN
FAYETTEVILLE
NEWTONSVILLE
OHIO
WILLIAMSBURG
MOUNT ORAB
MOWRYSTOWN
EAST FORK RESERVOIR
SAR
BETHEL
WINCHESTER
WHITEOAK RESERVOIR
GEORGETOWN
RUSSELLVILLE
FELICITY
HIGGINSPORT
OHIO
RIPLEY
KENTUCKY
ABERDEEN
LEGEND
AGRICULTURAL
INCORPORATED VILLAGES AND ADJACENT PRESENTLY DEVELOPED AREAS
RESIDENTIAL CONCENTRATIONS
PUBLIC OPEN SPACE
DEVELOPED PUBLIC RECREATION AREAS
INDUSTRIAL
COMMERCIAL
RESIDENTIAL - LOW DENSITY
MIGRATORY GOOSE REFUGE
BROWN COUNTY, OHIO
DEVELOPMENTAL LAND USE PLAN
U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W.VA. JANUARY 1968

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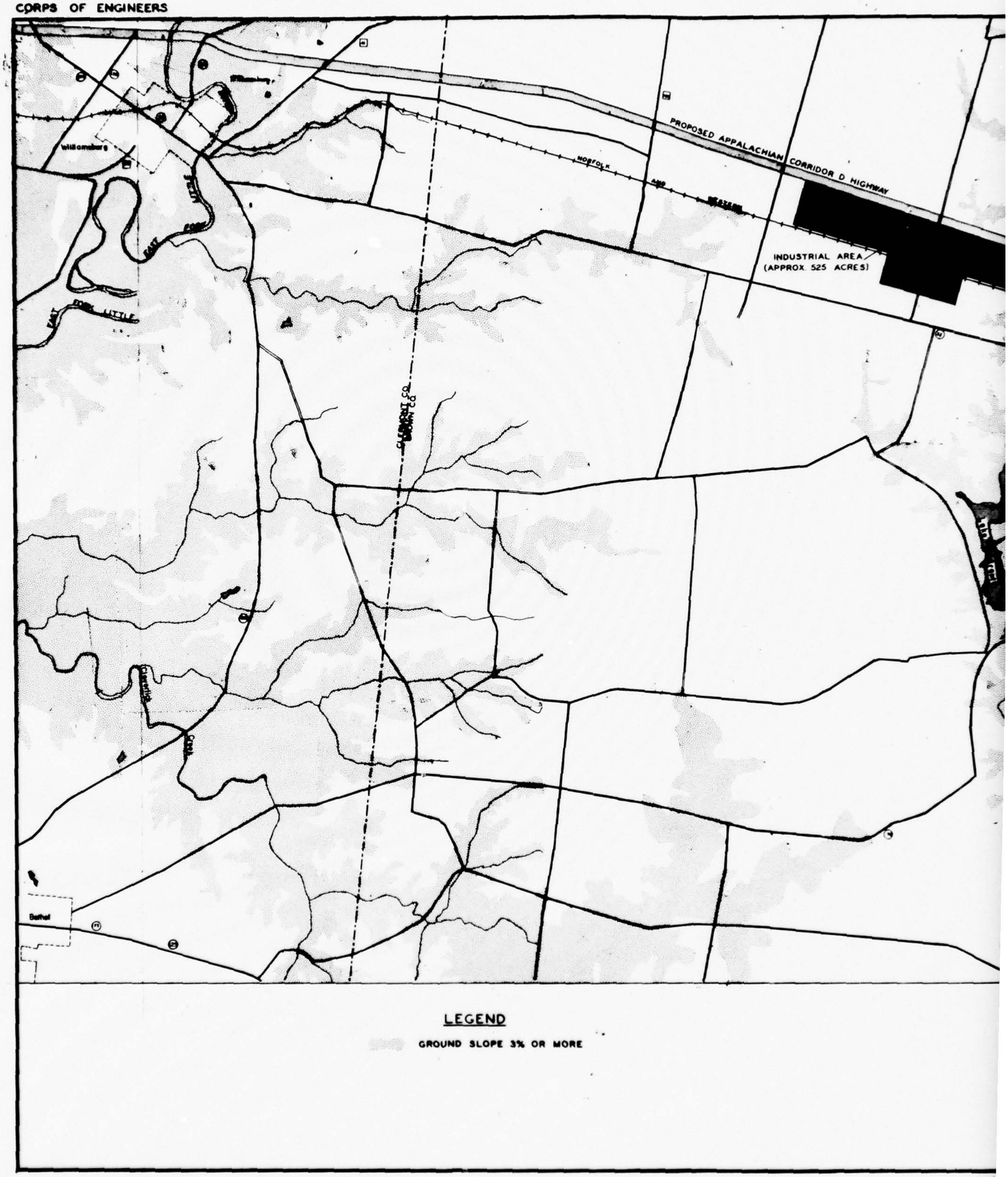
CORPS OF ENGINEERS



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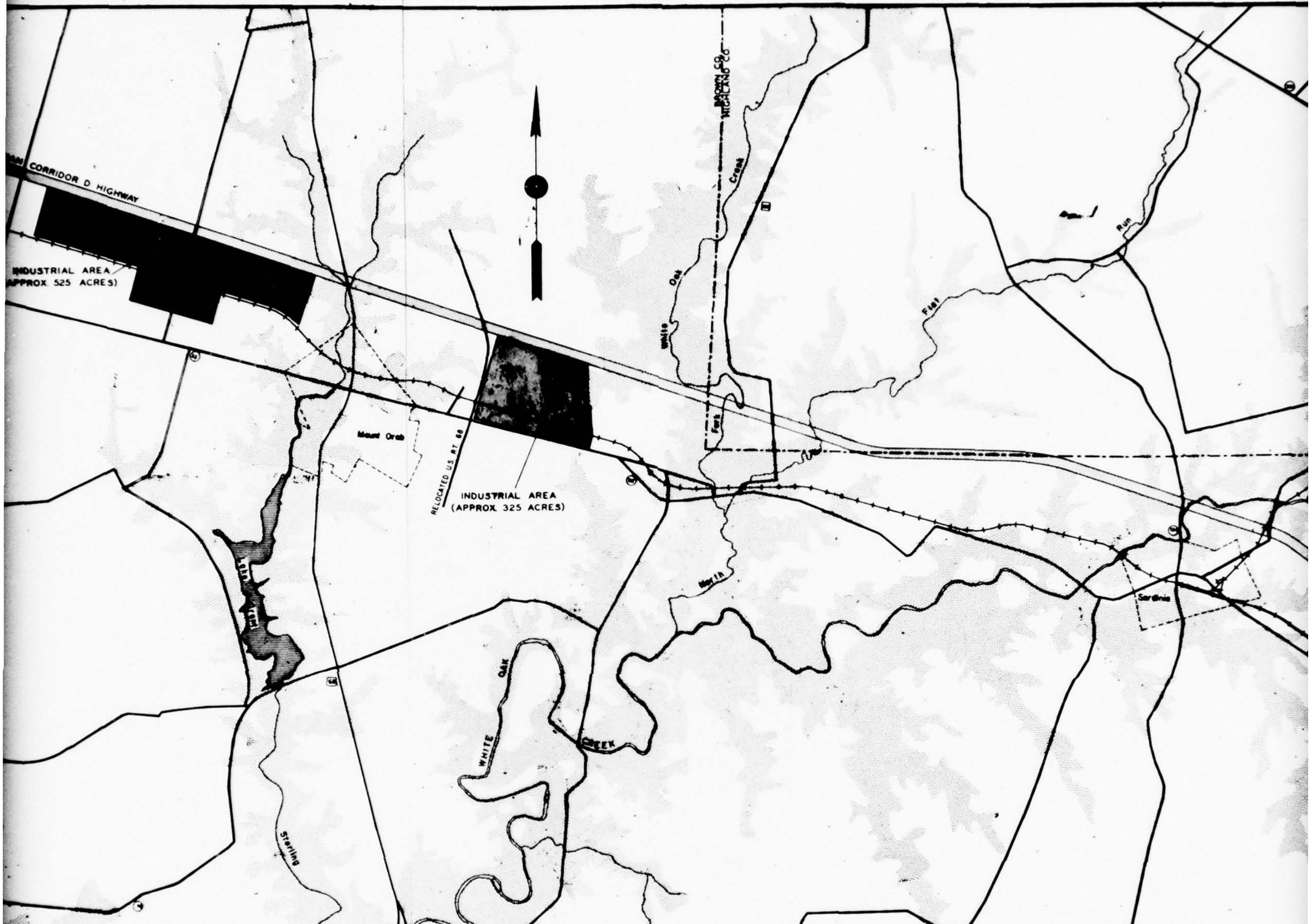
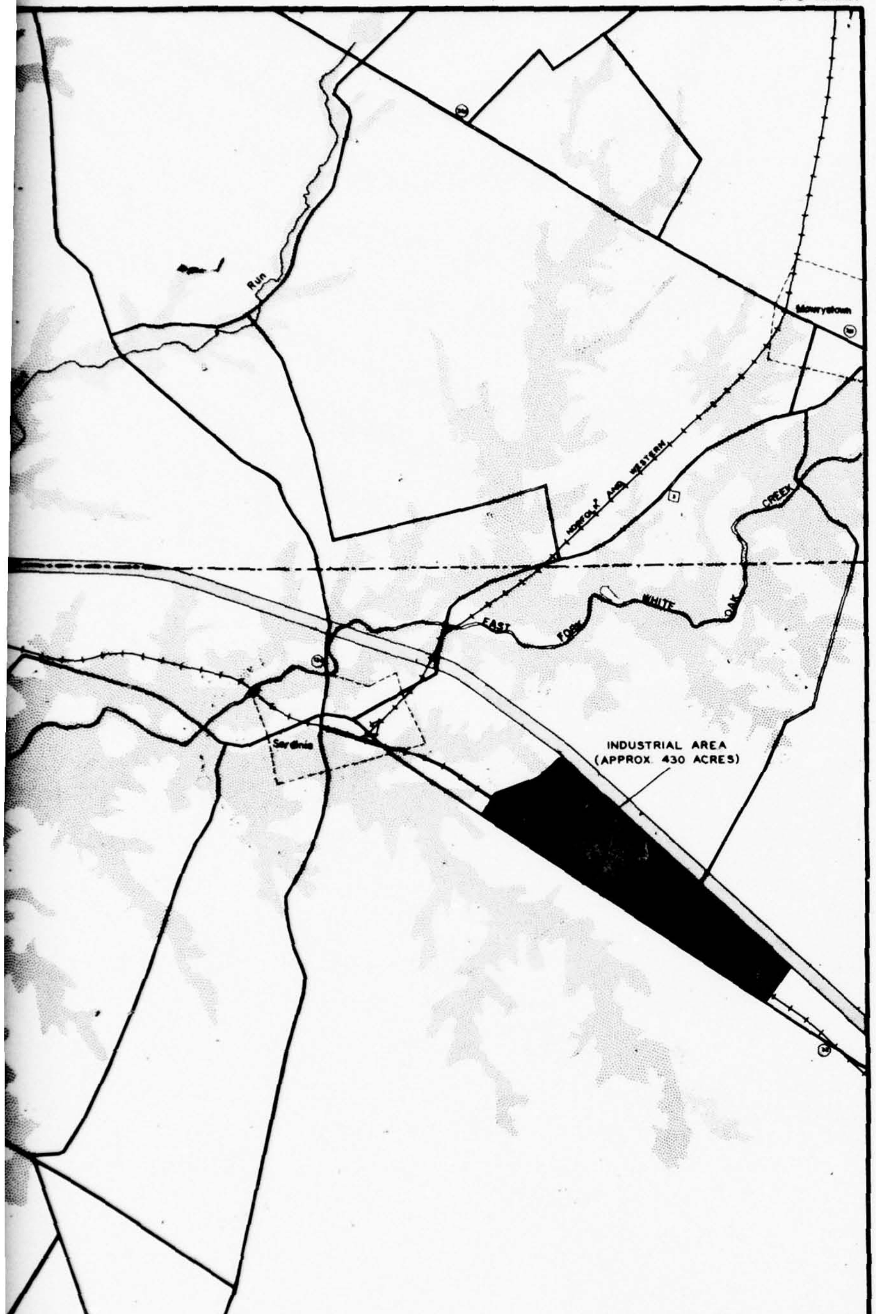


CORRIDOR D HIGHWAY
INDUSTRIAL AREA
(APPROX. 525 ACRES)
BROWN CO.
HIGHLAND CO.
White Oak
Creek
Fork
Flat
Run
Mount Orab
RELOCATED U.S. RT. 68
INDUSTRIAL AREA
(APPROX. 325 ACRES)
North
Sardinia
WHITE OAK CREEK
Sterling
Run
2000 0 2000 4000
SCALE IN FEET

3



WHITEOAK CREEK, OHIO

INDUSTRIAL DEVELOPMENT AREAS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT - CORPS OF ENGINEERS
HUNTINGTON, W. VA. AUGUST 1967

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 15

LOGAN DAM AND RESERVOIR PROJECT

Office of Appalachian Studies

Corps of Engineers

August 1969

SYLLABUS

The existing authorization for the Logan Dam and Reservoir is limited essentially to providing for flood control and uses incidental thereto. Over the period of 31 years since authorization, the water resource and economic conditions have changed considerably and have become more interrelated and complex. Only multiple-purpose development, responsive to the basic objectives contained in Senate Document No. 97 and the Appalachian Regional Development Act of 1965, would relate to the current composite problems.

The investigations reported herein primarily were designed to determine whether a justifiable project could be developed on Clear Creek, and whether such a project would respond to multiple-purpose objectives. The investigations disclose that such a project can be developed. Data presented in Part III, Chapter 15, are for the site at mile 3.1 on Clear Creek which was studied in detail, with an introduction and discussion of alternatives that will be subjected to later detailed investigations. Certain critical aspects involving non-quantifiable environmental quality and the lack of comparable engineering and economic detail for several alternatives make conclusions as to the specific site selections extremely difficult at this time.

It is proposed that the existing authorization be modified to be responsive to current needs. The exact dam site selection, between three and six miles above the mouth of Clear Creek, would be made, subsequent to authorization modification, during advance engineering and design studies after more information is developed concerning the alternative sites and when in-depth ecological determinations can be made and reported upon by all affected Federal and non-Federal interests.

The eventual decision regarding site selection would not appear to alter the principal conclusion that a multiple-purpose reservoir on Clear Creek, incorporating essential features generally as provided for herein, would be economically justifiable on the basis of national efficiency; would promote the general welfare and economic well-being of the region including substantial tangible and intangible gains to Appalachia; would be responsive to the composite of water and related resources needs of the basin as well as to the intense regional demands for water-based recreation; and would constitute an integral part of an optimum basin plan.

LOGAN DAM AND RESERVOIR

PERTINENT INFORMATION AND DATA

Location of dam: Hocking County, Ohio, on Clear Creek, a tributary of Hocking River, 3.1 miles above the mouth of Clear Creek, 80.1 miles above the mouth of Hocking River.

Study authority: House of Representatives resolution adopted 16 August 1950 and the Appalachian Regional Development Act of 1965.

Purpose of project: Flood control, water supply, water quality control, fish and wildlife enhancement, general recreation, preservation and enhancement of natural areas, and economic expansion.

Drainage area controlled: 84.1 square miles; equivalent to 18.7, 16.5, 14.5 and 8.9 percent of drainage areas above Rockbridge, Logan, Nelsonville, and Athens, respectively. Drainage area above gage on Clear Creek, 87.7 square miles.

Dam:		
	Type:	Rolled earth and random rock fill
	Top of dam:	890 feet above m.s.l.
	Maximum height:	114 feet
	Total crest length:	600 feet
	Slopes:	Upstream face 1 on 3.5
		Downstream face 1 on 3.0

Spillway: Open-cut, uncontrolled, broad-crested in the left abutment, crest elevation 868.3, crest length 100 feet, design discharge 18,400 c.f.s., head on crest 16.1 feet.

Outlet works: Intake structure with two gated sluices 5'-8" x 10'-0" and one 24" diameter low flow sluice discharging through a 10-foot diameter circular tunnel in right abutment into a stilling basin. Invert elevation 775 feet, m.s.l. Maximum outlet capacity 4,050 c.f.s.

Reservoir data:

Pool	Surface elevation	Capacity: Acre-feet Net	Capacity: Acre-feet Accum.	Capacity: Inches Net	Capacity: Inches Accum.	Pool area, acres
Minimum	813	5,000	5,000	1.1	1.1	312
Normal 1/	854	37,100	42,100	8.3	9.4	1825
Water supply		29,900		6.7		
Water quality control		7,200		1.6		
Flood Control	868.3	35,900	78,000	8.0	17.4	3100
Total	868.3	78,000		17.4		3100

1/ Surface of normal pool would be used as the recreation lake.

PART III

PROJECT ANALYSIS

CHAPTER 15 - LOGAN DAM AND RESERVOIR PROJECT

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PART III

PROJECT ANALYSIS

CHAPTER 15 - LOGAN DAM AND RESERVOIR PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

The Logan multiple purpose reservoir would be located on Clear Creek, a tributary of the Hocking River, in the Hocking Hills region of Ohio, approximately 30 miles southeast of Columbus. The location is shown on exhibit 15-1. The 115-foot high dam would be located in Hocking County and the reservoir would extend upstream into Fairfield County. Hocking County is within the Appalachian Region while Fairfield County is not. The project would control 84.1 square miles of drainage area in the headwaters of the Hocking River Basin.

The major physical features of the project would be the 600-foot long earth and rock fill dam; a 100-foot wide uncontrolled spillway; an intensively developed recreation park around the periphery of the 1825-acre recreation lake formed by the water supply-water quality control-recreation normal pool. Total storage at full pool would be 78,000 acre-feet, equivalent to 17.4 inches of runoff.

The project also would include a 3,800 acre nature area to be developed cooperatively by the Ohio Department of Natural Resources. The nature area would include a Resident Outdoor Education Center, a Nature Interpretive Center, approximately 10 miles of hiking and nature trails, and the Neotoma Ecological Research Area.

2. PROJECT IMPACTS

The reservoir project has been planned to provide services to satisfy the water resources and related needs of the area, and thereby encourage development of the Hocking River Basin, both in and outside of the Appalachian Region. The tangible benefits to be derived from the project would include:

Flood damage reduction along the Hocking River and the Ohio River.

Water supply for the city of Lancaster and other communities along the Hocking River.

Improvement of water quality along the Hocking River.

Outdoor recreation.

Fish and wildlife enhancement and nature preservation and enhancement.

Economic development.

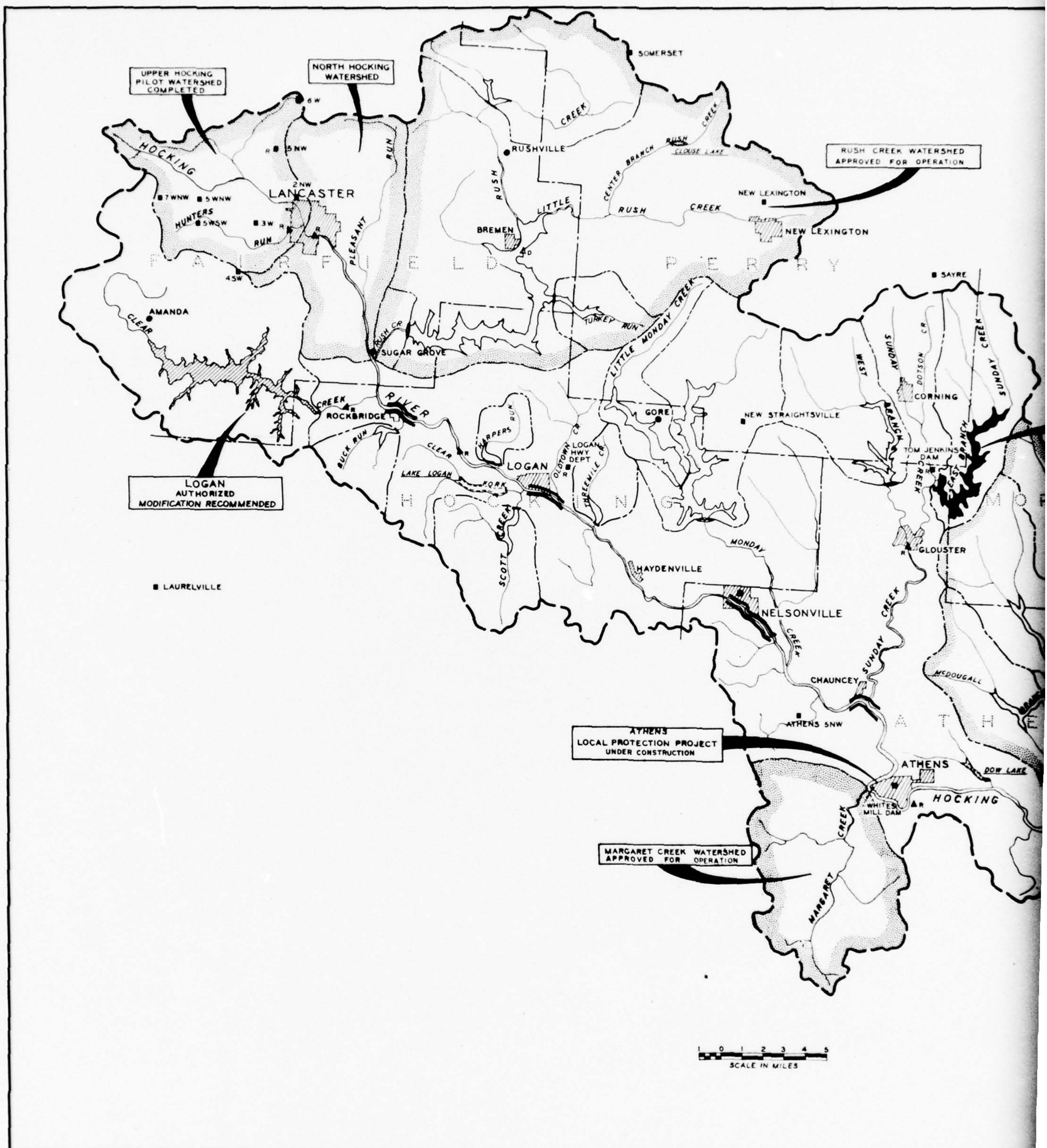
The flood control function of the reservoir project would effect reductions of flood heights along both the Hocking River and the Ohio River. Storage allocated for water supply would provide for a maximum of 24 million gallons per day and would meet the projected needs for Lancaster through year 2070. The water quality control storage will maintain a minimum flow of 15 c.f.s. which would meet the water quality needs in the Hocking River to year 2020 and would meet fishery requirements downstream of the project. In the period 2020 to 2070 additional augmentation would be furnished in August and September to satisfy water quality demands. A complete recreational complex is contemplated, providing high quality outdoor recreation opportunities for an estimated ultimate visitation of 2,652,000 annually. Facilities will be provided to accommodate 40,000 man-days annually at the reservoir and downstream fishery. Hunting lands are expected to attract about 4,500 hunters annually. The nature area would provide opportunities for nature interpretation and enjoyment of natural beauty for about 120,000 visitors annually.

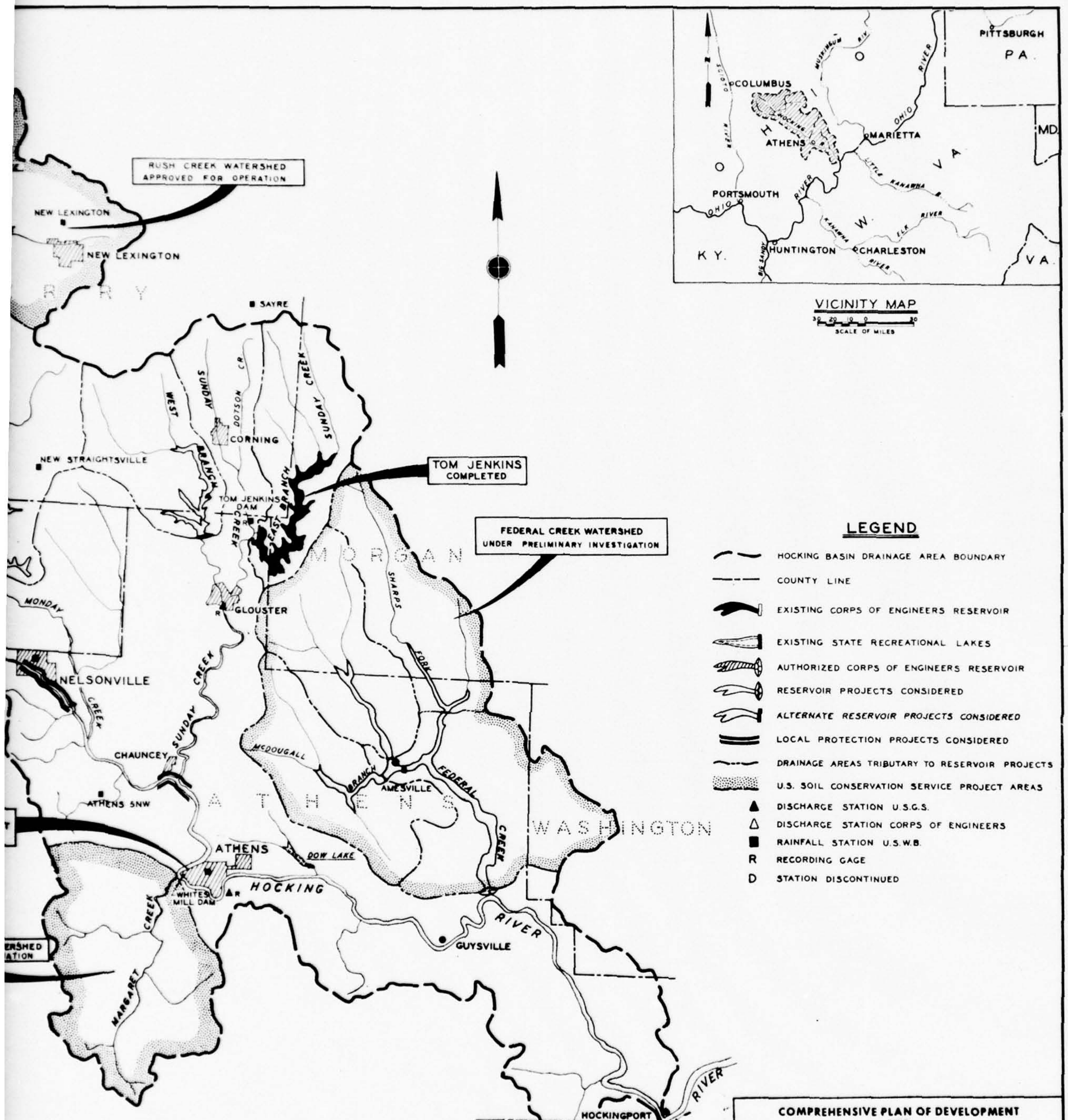
3. COSTS AND BENEFITS

Construction costs for the Logan Dam and Reservoir Project, including the recreation development and the Clear Creek Nature Area, would be $44,141,000. Annual charges, including interest and amortization on the construction costs, would average $2,299,000. The additional annual value of associated commercial investment would be $4,876,000. Average annual benefits are summarized below:

	Benefits	
	National	Regional
User	$3,080,000	$ 1,520,000
Expansion Effects	$2,043,000	$ 9,774,000
Redevelopment	(78,700)	(259,000)
Development	(1,963,800)	(9,515,000)
Total	$5,119,000	$11,294,000

The performance index for the traditional objective of increasing national income through user effects and redevelopment would be 1.4. For the single objective of increasing regional employment, the performance index would be 1.4. The total economic impact of the project is reflected by the combined regional and national effects which would derive an average of $12,854,000 in benefits annually.


UPPER HOCKING PILOT WATERSHED COMPLETED
NORTH HOCKING WATERSHED
RUSH CREEK WATERSHED APPROVED FOR OPERATION
LOGAN AUTHORIZED MODIFICATION RECOMMENDED
ATHENS LOCAL PROTECTION PROJECT UNDER CONSTRUCTION
MARGARET CREEK WATERSHED APPROVED FOR OPERATION
SOMERSET
RUSHVILLE
LANCASTER
NEW LEXINGTON
BREMEN
AMANDA
SUGAR GROVE
ROCKBRIDGE
LOGAN
GORE
NEW STRAIGHTSVILLE
CORNING
SAYRE
TOM JENKINS DAM
GLOUSTER
HAYDENVILLE
NELSONVILLE
CHAUNCEY
ATHENS 5NW
ATHENS
WHITES MILL DAM
DOW LAKE
LAURELVILLE
LOGAN HWY DEPT
CLOUSE LAKE
LAKE LOGAN
FAIRFIELD
PERRY
HOCKING
ATHENS
HOCKING RIVER
HUNTERS RUN
PLEASANT RUN
RUSH CREEK
LITTLE RUSH CREEK
CENTER BRANCH RUSH CREEK
CLEAR CREEK
TURKEY RUN
LITTLE MONDAY CREEK
MONDAY CREEK
SUNDAY CREEK
WEST BRANCH SUNDAY CREEK
EAST BRANCH
DOTSON CR
BUCK RUN
HARPERS RUN
CLEAR FORK
OLDTOWN CR
THREEMILE CR
SCOTT CREEK
MARGARET CREEK
MCDOUGALL
SCALE IN MILES



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

HOCKING BASIN MAP

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4. COOPERATION REQUIRED FOR CONSTRUCTION

The Corps of Engineers would assume responsibility for land acquisition, relocations and construction for the project subject to reimbursement of those costs apportioned to the State of Ohio. The reimbursable costs would include all costs allocated to water supply; one-half of the separable construction costs for recreation; and one-half of the construction costs for enhancement of the Clear Creek Nature Area. The state, through its Department of Natural Resources, would assume responsibility for operating and maintaining the recreation development and the nature preserve and would bear all costs associated therewith.

The plan of development presented herein reflects to a great extent the views and desires of the state. The Director of the Department of Natural Resources has concurred in the plan of development and has affirmed the state's intent and willingness to provide formal assurances, prior to construction, that it will meet the necessary requirements of cooperation.

5. PERTINENT LEGISLATION AND POLICY

The Flood Control Act of 1936 recognized flood damages and flood control as national problems; stated it to be the sense of Congress that flood control is a proper activity of the Federal Government in cooperation with the states, political subdivisions and localities thereof; and declared that solution of flood problems is in the interest of the general welfare so long as the benefits, to whomsoever they may accrue, are in excess of the estimated costs.

The Flood Control Acts of 1938 and 1941 modified the 1936 Act to eliminate certain major requirements of local cooperation for dams and reservoirs, while retaining them for local protection projects.

The Flood Control Act of 1944 extended the definition of flood control to include channel and major drainage improvements; authorized the Chief of Engineers to develop and operate public parks; authorized the Secretary of the Army to contract for sale of surplus water; and further redefined roles of the Departments of Agriculture, Interior and Army, in watersheds, irrigation, flood control and electric power. The 1944 Act also reaffirmed Federal interest in planning "to preserve and protect to the fullest possible extent established and potential uses, for all purposes, of the waters of the Nation's rivers, to facilitate the consideration of projects on a basis of comprehensive and coordinated development."

The Flood Control Act of 1948, as amended, provided for construction of small flood control projects not specifically authorized by Congress when, in the opinion of the Chief of Engineers, such work is advisable and constitutes a complete solution to the flood problem

involved so as to not commit the United States to additional improvements to insure effective operation except as may result from the normal procedure applying to projects subsequently authorized. The Federal share in such projects may not exceed $1,000,000.

The Federal Water Pollution Control Act of 1956 establishes water quality storage as a project purpose in Federal reservoirs if benefits are widespread. Provides for preparation or development "of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface underground waters......due regard shall be given to the improvements which are necessary to consume such waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses."

The Water Supply Act of 1958 recognized water supply as a purpose in Federal multiple-purpose water resource development. Cost of water supply provisions shall be borne by state or local interests.

The intent of the Federal Water Project Recreation Act of 1965 is that full consideration shall be given to opportunities for outdoor recreation and for fish and wildlife enhancement in investigating and planning any Federal navigation, flood control, reclamation, hydroelectric or multiple-purpose water resource project. Whenever any such project can reasonably serve either or both these purposes consistently with the provisions of the Act, it shall be constructed, operated, and maintained accordingly. Planning of the recreation development shall be based on the coordination of the recreational use of the project area with the use of existing and planned recreation developments. Non-Federal public bodies shall be encouraged to administer project land and water areas for recreation and fish and wildlife enhancement purposes and to operate, maintain, and replace facilities for these purposes.

In 1962, a document titled "Policies, Standards, and Prodecures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources" was approved by the President as a statement of executive policy. The document was printed as Senate Document No. 97. It provided broad policy guidance to the Corps of Engineers and other agencies in their planning efforts, defined objectives, cited broad policy for multi-purpose, river basin, and individual project planning and stressed coordination of plans within the Federal and non-Federal agencies. The document states:

"II. OBJECTIVES OF PLANNING

The basic objective in the formulation of plans is to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable short- and long-term needs. In pursuit of this

basic conservation objective, full consideration shall be given to each of the following objectives and reasoned choices made between them when they conflict:

A. Development

National economic development, and development of each region within the country, is essential to the maintenance of national strength and the achievement of satisfactory levels of living. Water and related land resources development and management are essential to economic development and growth, through concurrent provision for--

Adequate supplies of surface and ground waters of suitable quality for domestic, municipal, agricultural, and industrial uses--including grazing, forestry, and mineral development uses.

Water quality facilities and controls to assure water of suitable quality for all purposes.

Water navigation facilities which provide a needed transportation service with advantage to the Nation's transportation system.

Hydroelectric power where its provision can contribute advantageously to a needed increase in power supply.

Flood control or prevention measures to protect people, property, and productive lands from flood losses where such measures are justified and are the best means of avoiding flood damage.

Land stabilization measures where feasible to protect land and beaches for beneficial purposes.

Drainage measures, including salinity control where best use of land would be justifiably obtained.

Watershed protection and management measures where they will conserve and enhance resource use opportunities.

Outdoor recreational and fish and wildlife opportunities where these can be provided or enhanced by development works.

Any other means by which development of water and related land resources can contribute to economic growth and development.

B. Preservation

Proper stewardship in the long-term interest of the Nation's natural bounty requires in particular instances that--

There be protection and rehabilitation of resources to insure availability for their best use when needed.

Open space, green space, and wild areas of rivers, lakes, beaches, mountains, and related land areas be maintained and used for recreational purposes; and

Areas of unique natural beauty, historical and scientific interest be preserved and managed primarily for the inspiration, enjoyment and education of the people.

C. Well-being of people

Well being of all of the people shall be the overriding determinant in considering the best use of water and related land resources. Hardship and basic needs of particular groups within the general public shall be of concern, but care shall be taken to avoid resource use and development for the benefit of a few or the disadvantage of many. In particular, policy requirements and guides established by the Congress and aimed at assuring that the use of natural resources, including water resources, safeguard the interests of all of our people shall be observed."

Senate Document No. 97 provides for full consideration of recreation as a purpose in project formulation and evaluation. In 1964, Supplement No. 1 to that document provided standards for the evaluation of recreation benefits from the use of recreation resources provided by water and related land resources development projects.

In addition to the legal and formal executive policy actions affecting water resources development by the Federal Government, the following precepts enunciated by the President in his special message to Congress, on natural resources, February 23, 1961, are applicable as guidance for the civil works program.

Research on all aspects of natural resources will be increased.

Emphasis will be placed on the development of comprehensive plans for major river basins.

Increased attention will be given to multiple-purpose and industrial water supplies.

A program of providing data on flood hazards will be accelerated to assist in regulating the use of flood plains.

An effort will be made to preserve reservoir sites for later development.

Sufficient land will be acquired at reservoir sites to develop the recreation potential.

A full-scale attack will be made on the water pollution problem.

All agencies of Government should work together in the interest of providing a greater recreation resource for the people of the United States.

Section 206 of the Appalachian Regional Development Act of 1965 authorized preparation of a comprehensive plan for the development and efficient utilization of the water and related resources of the

Appalachian region; giving special attention to the need for an increase in the production of goods and services within the region as a means of expanding economic opportunities and thus enhancing the welfare of its people. The plan may recommend measures for flood control, municipal and industrial water supply, hydroelectric power, prevention of water pollution by mine drainage, recreation development, river navigation and such other measures as may be necessary.

The studies reported herein were prepared in partial response to the Appalachian Regional Development Act of 1965; in compliance with a resolution of the House of Representatives Committee on Public Works requesting a review of reports on the Hocking River and tributaries; and within the framework and context of the legislation and policies discussed in the preceding paragraphs.

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SECTION II - PROJECT FORMULATION

6. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

Effect of existing projects on flood problems - Past efforts to control flooding in the Hocking River Basin have resulted in alleviation of flooding in certain areas but have provided little protection along the main stem where the greatest and most recurring damages are experienced. The Tom Jenkins Reservoir on the East Branch of Sunday Creek, completed by the Corps of Engineers in 1951, controls about 33 square miles of drainage area and provides the town of Glouster and rural communities in the Sunday Creek Valley with a substantial degree of protection. It provides only minor reductions along the Hocking River. The Upper Hocking Watershed Project of the United States Department of Agriculture (USDA), a "Pilot Watershed," constructed under the authority of the Department of Agriculture Appropriation Act of 1954, includes nine flood water retarding structures and some channel improvements which substantially alleviate flooding in the basin at and upstream from Lancaster, Ohio. The USDA has claimed no flood control benefits along the river below Lancaster in its economic evaluation of the watershed plan.

Existing Corps of Engineers projects throughout the Ohio River basin effect substantial reductions in flood stages along the Ohio River. The existing reservoirs and local protection projects combine to reduce average annual damages along the Ohio River by nearly 90 percent.

U. S. Department of Agriculture programs - The USDA has watershed projects for Rush Creek and Margaret Creek approved for operations and recently completed a preliminary investigation for the Federal Creek watershed. Local interests also have submitted an application for assistance under Public Law 566, for the drainage area of the Hocking River above the mouth of Rush Creek. The study area, designated as the North Hocking Watershed, would incorporate the completed Upper Hocking projects. The combined projects will virtually eliminate all significant damages throughout the major tributary basins in which they occur. The effects of the completed Upper Hocking projects have been evaluated and are considered to be negligible at Athens, Logan and Nelsonville. A lack of information on the proposed structures in the Rush and Margaret Creek Watersheds during the hydrologic analysis pertinent to this report precluded an evaluation of the flood control effects of these structures throughout the Hocking River Basin.

Remaining flood problems occurring as damages to improvements - Practically all remaining flood damages to improvements within the Hocking River Basin are confined to the 55-mile stretch of the main stem between Guysville and Rockbridge which now average $668,000 annually. Approximately 74 percent of the damages to improvements occur at Athens, with the smaller cities of Logan and Nelsonville sustaining 11 and 10 percent of the damages, respectively. The remaining 5 percent of damages is distributed throughout the rural reaches. These rural reaches also

sustain the majority of crop damages within the basin, averaging about $96,000 annually. A summary of average annual damages in the Hocking River Basin is given in Table 15-1. A comparison of flood levels and damages for a 1-year frequency flood and a 100-year frequency flood is given in Table 15-2.

TABLE 15-1
AVERAGE ANNUAL FLOOD DAMAGES
HOCKING BASIN
(Based on July 1968 prices and level of development)

IMPROVEMENTS		DAMAGES
Reach		
Rockbridge		$ 11,600
Enterprise		400
Enterprise to Logan		10,300
Logan:		
(Area 1) West and south Logan	$ 4,300	
(Area 2) Downstream end of Logan	47,100	
(Area 3) Main Logan	20,600	
Total, Logan		72,000
Logan to Nelsonville		1,900
Nelsonville		65,900
Doanville		2,000
Doanville to Chauncey		1,100
Chauncey		3,600
Athens:		
Institutional	$140,900	
Non-institutional	354,800	
Total, Athens		495,700
Athens to Guysville		3,300
Guysville		200
Total Improvements		$668,000
CROPS		
Clear Creek to Scott Creek		$ 3,000
Scott Creek to Monday Creek		65,500
Monday Creek to Sunday Creek		8,800
Sunday Creek to Guysville		18,700
Total Crops		$ 96,000
OTHER DAMAGES		
Total Other Damages		$ 31,000
TOTAL DAMAGES		$795,000

TABLE 15-2
COMPARISONS OF FLOOD LEVELS AND
DAMAGES FOR 1-YEAR AND 100-YEAR
FREQUENCY FLOODS UNDER EXISTING
CONDITIONS AT MAJOR DAMAGE CENTERS

	1-year frequency flood	100-year frequency flood	Difference
Rockbridge			
Flood Elev. m.s.l.	747.4	757.0	9.6
Damage	$ 0	$161,000	$161,000
Logan			
Flood Elev. m.s.l.	718.4	727.7	9.3
Damage	$ 0	$1,916,000	$1,916,000
Nelsonville			
Flood Elev. m.s.l.	676.6	683.3	6.7
Damage	$3,700	$ 825,000	$ 821,300
Athens			
Flood Elev. m.s.l.	633.0	641.2	8.2
Damage	$111,400	$2,194,000	$2,082,600

From an inspection of these two tables, one might get the impression that the average annual damages at Athens, Logan and Nelsonville are not consistent with the total damages caused by a 100-year frequency flood. It should be recognized that significant damages begin to occur at Athens for floods that occur as frequently as once every one or two years; whereas, Logan and Nelsonville are partially protected to relatively higher elevations, but incur severe damages when these critical elevations are exceeded.

The flood problem at Athens is particularly acute. The wide and relatively flat flood plain, crossed by several highways and railroads, would normally be conducive to extensive urban development; however, most of the development at Athens lies on the moderate to steep slopes surrounding the relatively undeveloped bottom land. Because of the scarcity of suitable building sites in the flood-free sections of Athens, a large number of residences and commercial, industrial and institutional establishments encroach upon the flood plain of the river. About one-third of the area at Athens inundated by the flood of March 1964 has been developed in this manner. This recent flood on the Hocking River inundated approximately 1,300 acres within and immediately adjacent to the city of Athens. Very recently, in May 1968, Athens had its highest recorded flood, which reached a crest stage of 24.63 feet. The March 1907 flood, the greatest known flood,

reached a height of 27.4 feet, or about 3.2 feet higher than the 1964 flood and about 2.8 feet higher than the 1968 flood. It flooded about 40 percent of the area presently within the corporate limits of Athens. Seven lives were lost and a number of the inhabitants were made refugees. Substantial damages have been incurred during several other floods in this century, including the floods of March 1913, January 1937, March 1945 and March 1963, which reached stages of 24.2 feet, 23.4 feet, 23.7 feet and 23.1 feet, respectively, on the Athens gage.

The expansion of facilities to accommodate the rapidly increasing enrollment of Ohio University has been seriously hampered in the past few years. The unavailability of flood-free land has forced the University to develop well into the flood plain. Their most recently constructed facilities are subject to some flooding on the average of about once every 15 years. Most of the land available for future construction is subject to flooding more frequently than once in ten years. The local protection project for Athens, authorized by Congress in 1965, and currently under construction, will consist of channel straightening and widening through the city, and will prevent 83.0 percent of the total average annual damages at Athens, currently estimated to be $495,700 (on a July 1968 level of development).

The flood situation at Logan is also accented by increased expansion into the flood plain, especially by industrial concerns downstream and east of Logan. The State of Ohio has constructed a highway fill and low dike, both in conjunction with the new U. S. Highway No. 33, which will partially protect this industrial area from direct and backwater flooding from the Hocking River.

Remaining flood problems occurring as indirect damages - Indirect damages occur as a result of Hocking River floods which are most difficult to evaluate monetarily. The resulting human misery and inconvenience is often overshadowed by the attention focused on progress and industrial development in the flood plains. Loss of wages due to lack of access to work, interruption of public utilities, detours and outages as a result of highway inundations and increased costs of replacing home furnishings destroyed in floods are a few of these special categories of damage that pose a severe hardship to the more unfortunate people in the basin. These additional problems are not entirely independent of industrial progress and development, however, and can only multiply with the expansion in the flood plain.

Remaining flood problems occurring as future damages. Land filling and flood proofing techniques have helped to diminish the possibility of damage that would normally occur to industrial, commercial and institutional structures erected in the flood plains at Logan and Athens. However, future damages will be sizeable and large floods could cause serious business loss in the basin. It is assumed that industrial expansion will continue to occur in the Logan and Athens areas and that this expansion will be closely aligned with transportation improve-

ments now being made to connect these cities with the Columbus-Lancaster area. In addition, institutional development in the flood plain at Athens has been substantial and is expected to continue into the near future. It is estimated that future average annual damages prevented by proposed local protection projects and Logan Reservoir at the cities of Logan, Nelsonville and Athens will exceed average annual damages prevented to the existing development by at least 10 percent. Accordingly then, remaining flood problems occurring as future damages in the next 50 years would be at least half again as great as the damages to the existing development and would exceed these damages in the next 100 years.

Remaining flood problems occurring on the Ohio River - Although existing reservoirs and flood protection projects throughout the Ohio River basin substantially reduce damages, the residual damages average $11,000,000 annually. The Ohio River has an unusually wide range in flood stages. The extreme high water reached a stage of 80 feet at Cincinnati during the 1937 flood; 28 feet above the stage at which overbank flooding begins. Consequently, it is highly desirable to reduce stages by means of reservoirs in order to reduce the expense of high levees and flood walls at damage centers. Reservoir control is also beneficial to rural and moderately developed areas along the main stem where local protection is impractical and uneconomical. The uncontrolled flows from the Hocking River contribute to the flood heights along the Ohio River.

Effects of damages on economic growth - The vast majority of land within the vicinities of Athens, Nelsonville and Logan, suitable for commercial and industrial development, is subject to flooding more frequently than once in 100 years. A flood that would recur once in 100 years on the average is considered an intermediate regional flood by Federal and state agencies. Its magnitude is based on the flooding characteristics of the region in question. Increasing awareness of the desirability to keep damageable improvements above the estimated elevation of a 100-year flood, will tend to discourage development below such an elevation. Developers will become more reluctant to invest capital in flood prone areas.

In the past a great number of industrial and commercial structures have been built along the Hocking River with first floor levels, machinery, stock and furnishings subject to flooding on the average of once every 25 to 35 years. The unawareness of the potential hazards combined with a willingness to take unknown risks has made possible the level of development that now exists. At least one industry has indicated that the flood problems encountered since it located on the flood plain has put it at a severe competitive disadvantage.

Both Logan and Athens have aggressive local non-profit organizations engaged in industrial development. Nearly all of the potential industrial sites now owned by these organizations are subject to

periodic flooding. These organizations have repeatedly indicated that the flood hazards constitute a major handicap in attracting industry. The flood plain lands were selected, not without a knowledge of the hazards, but because there are few other sites not subject to flooding.

Water supply and maintenance of stream quality - Hardness and iron content are prevalent in most of the surface waters of the basin including the main stem of the Hocking River. These undesirable qualities in combination with severe and widespread acid mine drainage in certain areas necessitate extremely expensive water treatment for municipal and/or industrial use. Well fields have been established as the primary water source along the main stem of the Hocking River. There is no substantial deficit in the quantity of the existing ground water supply; however, the subsurface waters have a high degree of hardness and iron content requiring comparatively high treatment costs. Since the development of water supply in the Tom Jenkins Reservoir, no communities in the immediate area of that reservoir have chronic supply deficiencies. Lancaster's present underground source has a hardness which has been steadily increasing and currently is in excess of 400 milligrams per liter (mg/l). The present quality of the Hocking River at Lancaster causes direct withdrawal from the river to be uneconomical.

The Federal Water Pollution Control Administration (FWPCA) estimated that the total average annual demand for water supply for Lancaster would reach 12.0 million gallons per day (m.g.d.) by 2020 and 20.0 m.g.d. by 2070. Demand for the average summer month would reach 14.4 m.g.d. by 2020 and 24.0 m.g.d. by 2070. The present average annual demand is about 5.0 m.g.d. Thus, the water supply demand for Lancaster will increase four-fold during the economic life of any reservoir to be considered. The FWPCA projected only those demands for the Lancaster area. They indicated, however, that the major portion of any water supplied to Lancaster would be treated and returned to the Hocking River after use. After further purification in the river and mixing with natural and regulated streamflows, the water would then be available for use further downstream along the Hocking River. Ground water downstream along the Hocking is very hard and requires treatment for most uses. The city of Nelsonville abandoned ground water as its source of supply for this reason.

The FWPCA estimated the required flows in Clear Creek to provide water quality control in the Hocking River. Until the year 2020, a minimum release from any reservoir on Clear Creek of 15 cubic feet per second (c.f.s.) would meet both downstream fishery needs along Clear Creek as recommended by the U. S. Fish and Wildlife Service and the water quality needs estimated by FWPCA. For comparison, the base flow in Clear Creek averages about 7.9 c.f.s (based on seven-day, once in ten year conditions). Additional flows would be required during

September and October beginning in 2020. Total required streamflows would reach 20 c.f.s. during these months by the year 2070. The recommended minimum releases would satisfy streamflow requirements during the remaining months.

The FWPCA concluded that the return flows from adequate future supply of municipal and industrial water for the Lancaster area, in conjunction with natural and regulated flows, would assure adequate water supplies for the communities and industries that are now located or wish to locate in the valley of the Hocking River below Lancaster. Also, FWPCA concluded that a reservoir on Clear Creek will benefit a wide spectrum of water uses in the study area and that the availability of water of more uniform quality and quantity would provide a strong attraction to new industries.

Most of the river's major tributaries, especially Sunday, Monday and Federal Creeks and the upper reaches of Rush Creek, are heavily polluted with acid mine drainage. These streams also carry high concentrations of sulfate, metals and hardness. Outflow from these streams into the main stem of the Hocking River is insufficiently diluted to provide an acceptable quality. The only major tributary of the Hocking River exhibiting acceptable quality is Clear Creek which has a maximum hardness during extremely low flow conditions of 150 mg/l in contrast to the maximum hardness of 700 mg/l in the Hocking River at Athens. This factor alone practically eliminates possible reservoir sites on most other tributaries as competitive alternatives to the Logan Reservoir site for multiple purpose development.

The acid mine drainage problem has not been resolved in the course of the studies reported herein. Coal reserves are present in three quarters of the basin. (See Appendix C). In 1965, 1,600,000 tons were produced. Surface mine operations accounted for about 80 percent of this total. The total recoverable coal reserve is estimated at over one billion tons, representing a substantial potential for continued and expanded coal production. The FWPCA estimates that an acid load of 200 tons per day is discharged into the basin's streams and that the load will increase to 990 tons per day by the year 2020 unless corrective measures are taken. However, the FWPCA estimates that acid mine drainage loads can be reduced 80 percent through regulatory control measures for active operations and a physical abatement program for inactive operations. If this magnitude of reduction is achieved, it is expected that the basin's streams will be able to assimilate the residual loads without any significant quality disturbance. No further consideration was given the acid mine drainage problem for the purposes of this report. Provisions have been made for continuing studies under Section 206 of the Appalachian Regional Development Act.

It should be noted that only a small portion of the Clear Creek watershed downstream from the glacial divide is underlain by coal-bearing deposits.

Recreation demands - The proposed Logan Reservoir site is located in the Hocking Hills State Park region and lies within seven miles of the center of the existing park complex. The park area has a radius of over five miles and includes Hocking Hills State Forest, Lake Logan State Park and six outstanding geologic areas encompassing over 10,000 acres of land in public ownership. The major deficiency in the Hocking Hills recreation region is the lack of broad water areas suitable for water-based recreation activities. The 1825 surface acres of Logan Reservoir will help satisfy a portion of the area's water-based recreation needs; however, it alone will not be sufficient to meet the demands existing and created within the zone. Per capita visits to State Parks in the zone of influence are about 1.6 times greater than the state wide per capita park visitation. Projections of population and per capita visitation figures indicate that the 1960 demand for outdoor recreation opportunities within the basin's zone of influence will increase over 450 percent by the year 2000.

The primary zone of influence was considered as the area within a 50 mile radius from the reservoir site on Clear Creek, and includes the Columbus metropolitan area. Table 15-3 summarizes the present and projected levels of population and demand for recreation opportunities within the primary zone of influence.

TABLE 15-3

RECREATION DEMAND IN PRIMARY ZONE OF INFLUENCE

Year	Population	Visitation	Demand (Recreation-days)	Unmet Demand
1960	1,280,000	3,200,000	9,600,000	6,400,000
1980	1,800,000	8,600,000 1/	22,000,000	13,400,000
2000	2,600,000	-	43,900,000	-
2020	3,730,000	-	71,200,000	-

1/ At current rate of development

Developing a National Recreation Area (NRA) which would incorporate the Logan Reservoir project would intensify the extreme demand for water-based recreation opportunities in the region and would polarize this demand at the Logan Reservoir and at other future impoundments that might be included in the NRA.

The NRA may cause a change in the nature of opportunities being demanded and a reorientation of access to the reservoir, but changes in the overall scale and scope of development would not be warranted.

The demands for opportunities will far exceed the ability of the project to meet those demands even if deterioration of the quality of the recreation experience were allowed, whether or not a NRA materializes. Thus, to provide a quality general recreation experience, taking optimum advantage of the favorable physical and aesthetic attributes of the reservoir area, the general scale and scope of recreation development would be the same under conditions either with or without being incorporated into a National Recreation Area.

Refinements in the type and orientation of facilities to accommodate the proposed National Recreation Area were not considered within the scope of this report, and should not substantially alter the conclusions of this study.

7. ALTERNATIVES FOR MEETING NEEDS OF THE HOCKING RIVER BASIN

Alternatives considered in previous studies - The essential components of the basin-wide plan of development were defined in the interim survey report. Basically, the ultimate plan would comprise the completed Tom Jenkins Reservoir; the completed, approved for installation, and planned watershed programs of the USDA; the Athens local protection project which is now under construction; and the potential Logan Reservoir project.

The Interim Survey Report on Hocking River Basin concluded that of the potential reservoir projects evaluated, only the Logan Reservoir Project would be economically justifiable. Fifteen potential reservoir sites originally were considered. Six of these were eliminated as a result of field reconnaissances and cursory evaluation of benefits. Further study of the remaining nine projects (of these, three small projects were alternates for one larger project) indicated that six of them were economically infeasible. The Logan Reservoir Project on Clear Creek, the Sugar Grove Reservoir Project on Rush Creek, and the Monday Reservoir Project on Monday Creek, were further considered with detailed estimates of annual costs and benefits. The detailed estimates disclosed that the Monday Reservoir was not economically justified even when acting separately. The Sugar Grove Reservoir, Logan Reservoir, and the Athens Channel Improvement Project were subjected to system analysis. The Sugar Grove project proved to be infeasible both when acting as a part of the three-project system and when acting in combination with the Athens project. The Logan and Athens projects would be feasible in any combination and were, therefore, retained as units of the basin plan.

Inclusion of Logan Reservoir would be contingent upon the findings of the survey scope studies, reported herein. Additionally, the plan would incorporate any improvements for local protection at other damage centers along Hocking River, found to be justifiable for construction under special continuing authorities provided the

Chief of Engineers. To supplement the flood protection program, flood plain information reports will be prepared for certain stream reaches.

Studies under special continuing authority - Concurrently with the survey scope studies for Logan Reservoir, four local protection projects were investigated under continuing authority for small flood control projects. Three of these projects were determined to exhibit potential for development. They would provide additional protection for Logan, Nelsonville and Rockbridge. No feasible project could be developed for Chauncey. Each of these communities is downstream of Logan Reservoir and would be provided some protection by that project. The mutual physical and economic effects of the reservoir project and the local protection projects upon one another were accounted for in the economic analysis and design of the projects.

A channel improvement project has been proposed for Logan which will increase the effectiveness of barriers (a dike and an extensive fill) constructed by the Department of Highways, State of Ohio, and will prevent 44 percent of the average annual damages, and when functioning with the proposed Logan Reservoir, will prevent 78 percent of the damages. A channel improvement project has also been proposed for Nelsonville which will increase the effectiveness of the existing levee and railroad fill there, and will prevent 51 percent of the total average annual damages and when functioning with the proposed Logan Reservoir, will prevent 72 percent of the damages. A snagging and clearing project has been approved for Rockbridge. This project will prevent only 18 percent of the average annual damages,but when functioning with the proposed Logan Reservoir, will prevent 58 percent of the damages.

Non-structural alternatives - flood plain management. The general condition along the Hocking River, where flood plain growth can be expected, is a lack of land adjacent to the flood plains that could be developed as alternative sites. This condition, and the fact that extensive development already exists on the flood plain, including major transportation facilities, supports supplemental rather than alternative programs for flood plain management; wherein prospective regulations to insure minimization of damages to vulnerable structures would be based on anticipated frequency of flooding with consideration being given to structural means of flood control. Lands lying between the natural and modified levels of anticipated flooding would be available for development, thereby responding to the premium values placed on flat lands within the natural flood plain.

Proposed flood plain management essentially would comprise locally adopted regulations based on flood hazard information data provided by the Corps of Engineers. To initiate this effort, a flood plain information report is being prepared for Athens, and similar reports will be prepared for Logan and Nelsonville when plans for local structural

measures have been completed. These reports, together with technical assistance to local officials and planners, are intended to create an awareness of potential flood hazards and to promote wise use of the flood plains.

Residual damages to existing improvements after all economical structural measures have been employed, will be difficult to eliminate. In certain instances, selective flood-proofing of individual structures could provide further alleviation of residual damages. But, in general, residential and light commercial structures do not lend themselves to floodproofing. The remaining alternatives would include gradual conversion of land to purposes that would minimize flood damage, and/or bearing the loss. If structural or non-structural solutions are neither feasible nor practical, bearing the loss becomes the only remaining alternative. Some aid in bearing the loss is available, such as disaster relief, income tax reductions, and low interest loans. In some areas, flood insurance may become available for existing development. However, subsequent to formal designation of the area as a flood hazard area in connection with a flood insurance program, it would not be eligible for Federal relief or other aid, in accordance with existing law.

8. FORMULATION OF THE PLAN FOR LOGAN DAM AND RESERVOIR

Site alternatives - The Clear Creek Basin constitutes only ten percent of the drainage area upstream of Athens on the Hocking River. Effective control of runoff from a substantial portion of Clear Creek Basin to meet the assessed needs for water supply, water quality control, and flood control would require a reservoir located entirely downstream of the town of Amanda on the main stem. The topography of the basin breaks sharply between the mouth of Clear Creek and Amanda, about five to six miles above the mouth, because of the effects of glaciation. The western portion of the basin is flat-to-rolling, glaciated till plain. The topography downstream of the glacier's terminus is characterized by sharp relief and narrow stream valleys. With relatively few improvements in the valley downstream of Amanda, a reservoir could be quickly conceived which would have its dam located in the narrow valley downstream of the transition from glaciated to unglaciated topography and with the reservoir extending upstream into the broad flat glaciated plains. Such a scheme would provide a maximum of reservoir storage and pool area for recreation usage relative to dam height and width. To take advantage of this attribute, the dam would have to be located between the mouth of the creek and a point approximately six miles above its mouth.

Map studies and field reconnaissances were made for the six-mile reach to locate suitable dam sites. From the mouth to about mile 2.0, the valley floor averages over 500 feet in width. From mile 2.0 to mile 4.0, the valley becomes gorge-like, averaging about 300 feet in bottom width, with steep walls. From mile 4.0 to mile 6.0, the valley again widens to about 500 feet in bottom width and its slopes are much

flatter than those of the lower and middle reaches. Valley widths at top of dam elevations would be 300 to 500 feet greater in the upstream or downstream reaches than in the middle reach. These dimensional characteristics of the valley indicated that the most economical structure could be built in the reach between mile 2.0 and mile 4.0. Field reconnaissance of the valley supported this conclusion and determined that the most adaptable site for an earthen structure would be at mile 3.1.

Since this site appeared to be the most suitable structurally and to provide the most economical reservoir project, it was selected as the principal site for formulation studies to determine the optimally scoped and scaled project. The monetarily optimum plan of development for this site, then, would serve as a basis for measuring the cost of deviating from such an optimum plan to provide any alternative plans which might be considered.

Scaling and scoping of hypothetically selected site - Selection of the site at mile 3.1 for formulation analysis did not constitute its selection as the site to be adopted, but allowed it to serve as the basic project against which to measure all alternatives incrementally.

The optimally scaled and scoped project for the site at mile 3.1 on Clear Creek, was formulated with a view to providing, to the extent commensurate with maximizing net monetary returns: (a) sufficient water quality control storage to supply the anticipated need for low flow augmentation; (b) sufficient storage to supply water to the city of Lancaster for municipal and industrial uses; (c) sufficient flood control storage to control all floods at the dam site that can reasonably be expected to occur and thus effecting the maximum possible reductions of flood flows along the Hocking River as well as along the Ohio River; (d) maximum development of the potential for meeting at least a portion of the demands for outdoor recreation; and (e) maximum employment opportunities as measured by the monetary return to the national economic account.

Cost and benefit estimates were computed for alternate levels of development and for alternative combinations of traditional purposes. These planning estimates were utilized in developing net benefits versus storage relationships. Table 15-4 summarizes the benefits and costs for all the projects comprising alternative combinations of purposes; each purpose being scaled to its maximum. As indicated in Table 15-4, the multiple-purpose project providing for all assessed needs would provide maximum net benefits and, therefore, represents the optimum scope. To establish the optimum scale, benefit-cost versus storage relationships were developed, based on detailed cost and benefit estimates for four levels of development with all purposes included, but with the recreation, water supply, and water quality control functions varying in magnitude as appropriate with

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TABLE 15-4

ECONOMIC EVALUATION OF ALTERNATIVE PROJECTS
HAVING VARIOUS COMBINATIONS OF PURPOSES

USER BENEFIT COMPARISONS
(Based on prices prevailing in July 1968)

Project	Av. annual benefits 1/	Av. annual economic costs	Net Benefits
Multiple purpose project 2/	$2,719,000	$2,207,000	$512,000
Tri-purpose alternatives:			
FC, R., WS	2,645,000	2,201,000	444,000
FC, R., WQC	2,544,000	2,194,000	350,000
FC, WS, WQC	639,000	913,000	-274,000
WS, WQC, R.	2,318,000	2,124,000	194,000
Dual purpose alternatives:			
FC, R.	2,481,000	2,187,000	294,000
R., WS	2,245,000	2,116,000	129,000
R., WQC	2,154,000	2,109,000	45,000
WS, WQC	239,000	847,000	-608,000
All others	-	-	Negative 3/
Single purpose alternatives:			
R.	2,080,000	2,102,000	-22,000
FC	401,000	697,000	-296,000
All others	-	-	Negative 3/

1/ Includes user benefits only

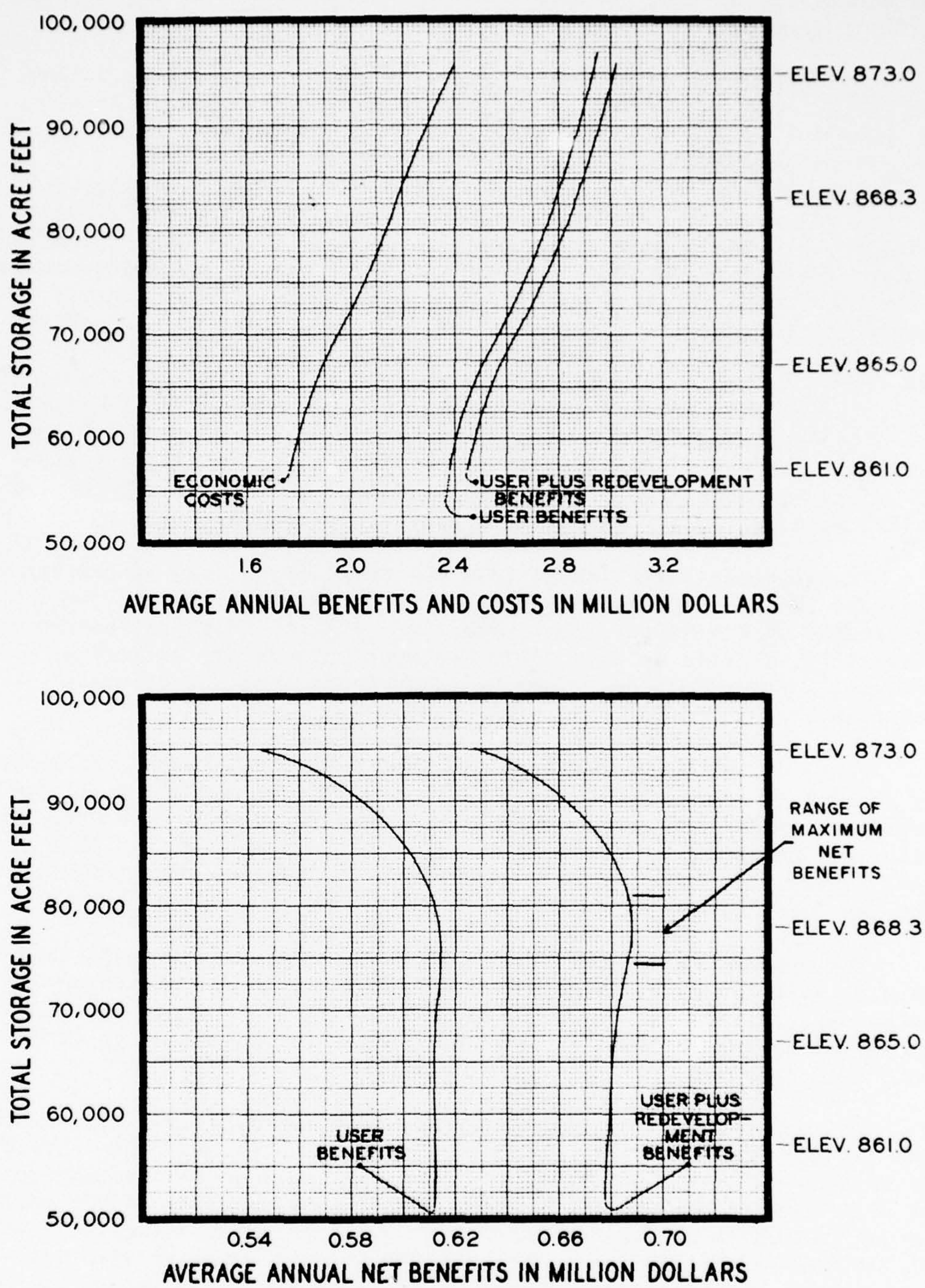
2/ Includes flood control, water supply, water quality control and recreation (without nature presure) as purposes, with storages just sufficient to provide for assessed needs for FC, WS & WQC but with no storage specifically for recreation.

3/ Economic costs clearly would exceed benefits. Estimates were not prepared.

corresponding increases or decreases in total storage. Flood control capacity, and thus flood control benefits, was held constant, thereby allowing water supply-water quality control-recreation (WS-WQC-R) pool storage to be the independent variable. The resulting curve, shown on exhibit 15-2, demonstrates that optimum return would be gained with total storage ranging from about 74,000 to 81,000 acre-feet. A total storage of 78,000 acre-feet with a corresponding WS-WQC-R pool storage of 42,100 acre-feet would be just sufficient to provide for all assessed water supply and water quality control needs. Any additional storage made available for water supply and/or water quality control would gain no increase in benefits for these purposes since the added storage would be in excess of the demands. The benefits claimed for these purposes were based on the estimated costs for providing the most economical alternative as derived by FWPCA. Thus, a project having a total storage of 78,000 acre-feet was selected as the monetarily optimum project. No surplus storage would be justifiable since additional WS-WQC-R pool storage of any significance would gain only a small, if any, increase in recreation benefits while incurring proportionally greater costs. The majority of the additional land acreage attributable to increasing the maximum pool level would be in the flat, glaciated portion of the reservoir area at the upstream end. This land becomes increasingly valuable as the reservoir is extended further upstream. Relocation costs would increase inordinately with increases in maximum pool levels of more than five feet.

The inclusion of 8.0 inches of flood control storage was found to be incrementally justifiable. Consideration was given to reducing flood control storage and increasing the WS-WQC-R pool level to gain additional recreation benefits. However, recreation benefits would not necessarily increase materially and no increase in water supply or water quality control benefits would be derived. The flood control function of the reservoir would be less effective. Although the effects of this lesser amount of storage on Hocking River and Ohio River flood flows was not analyzed in detail, it was considered that a lesser amount would be undesirable hydrologically. Investigations of flood control storage requirements considered not only recorded and historical floods on Clear Creek and Hocking River, but also intense storms and floods in adjoining basins. Such a storm occurred in March 1913, centering over Bellefontaine, Ohio. If a similar storm should occur over the Clear Creek Basin, it would require at least 8.0 inches of reservoir storage to control the resulting flood.

It should be noted that the pool elevations represented on exhibit 15-2 and used to establish the monetarily optimum level of development, cover a vertical range of only 12.3 feet. This range is less than the contour interval on the best available mapping. Detailed topographic mapping which would be developed in advance engineering and design studies could dictate changes or refinements in pool levels and storage values which now cannot be anticipated. It is concluded, therefore, that



LOGAN RESERVOIR
SCALE ANALYSIS
OF
MULTIPLE PURPOSE PROJECT

the monetarily optimum project scope and scale is adequately defined by the foregoing rationale.

Environmental and ecologic considerations - Clear Creek Valley, and the Neotoma Valley tributary in particular, has the distinction of being one of the most extensively investigated areas in the country by persons whose competence represents a wide range of scientific skills, all encompassed in the broad area of ecology. Neotoma Valley, constituting an outdoor laboratory, has for about 40 years become widely known among such scientists by the many technical studies carried to conclusion there and published in learned journals throughout the scientific world. This accumulation of scientific knowledge, whereby the conclusions of each investigation may set the guidelines for continuing subsequent studies, makes for a condition of research that has values far beyond the immediate economic or social significance that may appear associated with each separate finding. The problem of seeking alternatives in such a case is not a reliable rationale for evaluation, since each year that the studies are permitted to be conducted, substantially adds to the enhancement of the valley as a unique irreplaceable scientific resource.

Institutions for which Neotoma Valley has long been of particular interest include the Ohio State University, Ohio University, the University of Cincinnati, the University of Akron, Western Reserve University, Oberlin College, Ohio Wesleyan University, Wittenburg College, Wooster College, Miami University and some out-of-state colleges.

Other agencies and institutions that have participated in one way or another in these studies include the Ohio State Museum, U. S. Soil Conservation Service and Forest Service, Muskingum Watershed Conservancy District, Environmental Science Services Administration, the Ohio Biological Survey, the American Association for the Advancement of Science and the Ohio Academy of Science.

The Neotoma Valley has furnished outdoor laboratory conditions for studies associating soils physics and chemistry, plant physiology, plant pathology, effects of humidity, temperatures, air currents on animal and plant ecology as well as providing bases for solutions to earlier taxonomic problems.

The construction of Logan dam and reservoir at mile 3.1 will have two distinct effects with regard to continuation of Clear Creek Valley as an area of unique scientific value. One would be the inundation of what constitutes one of the more scenic sections including a portion of an area known as "Rhododendron Hollow." The other effect will be to accelerate substantially the rate of commercial and residential development already under way and which, soon after completion of the project, would be expected to alter drastically and destroy generally the present desirable aspects of the environment downstream of the dam.

Although many of the present landowners indicate their intentions to preserve their lands in a natural state, the influx of recreationists to the reservoir recreation development would have an adverse impact which would be difficult to control. Also, the lands under private ownership would not be accessible to that portion of the general public which is desirous of enjoying the very attributes which the landowners would be attempting to preserve. Heirs and/or future owners of the lands would be subject to great economic enticement to allow residential, commercial and private recreation development. These are recognized as consequential effects of project construction.

Consequently, the program presented herein seeks to prevent and/or mitigate the damages to unique scenic and scientific values that would be caused by inundation of the valley above the mile 3.1 site, and by the impact of the project on the area downstream of the mile 3.1 site, by placing in public ownership the area below the lower dam site, including Neotoma Valley, to protect it against the effects of urbanization and recreation crowds expected as a consequence of the construction of the project. The magnitude of acquisition required to insure preservation of this area and to make it available for controlled public usage, was determined jointly with the Ohio Department of Natural Resources. An area of about 3,800 acres would be required. Associated with the plan would be features of enhancement necessary to insure the integrity of the purpose the plan will serve, including controlled public usage, education and preservation. These features reflect the desires of the Ohio Department of Natural Resources to expand further, nature interpretation and study, as an integral part of its Parks and Recreation program. Thus the scientific investigations of Neotoma Valley would be permitted to continue and the remainder of the 3,800 acres would be opened for nature interpretation and enjoyment while being preserved essentially in its natural state. The facilities and features of development are set forth in the description of the plan of development in Section III.

The cost of acquiring the nature area would be a project induced cost to insure preservation, chargeable to the multiple purposes of the project. The costs of facilities evolve as a mutually dependent combination of mitigation and enhancement. As such, the plan for preservation cannot be judged as an economically independent increment to be viewed as an alternative subject to economic justification. It becomes an integral part of the monetarily optimum project previously formulated. Consequently, even specific items of enhancement cannot be subjected to an incremental justification decision for retention or deletion. In this instance, therefore, enhancement must be viewed as having a value equal to or greater than its cost and must be designed to adequately serve its intended purpose.

Alternative considerations - With the integration of the preservation program into the monetarily optimum project, substantiation of the economic and social propriety of the composite project requires

consideration of possible alternatives. These alternatives include either the status quo or an alternative reservoir site further upstream on Clear Creek to avoid the losses which would be incurred at the downstream site. Although precluding project development would avoid losses resulting from inundation, it would not insure preservation. Lands would remain in private ownership, largely posted against trespassing as at present, or to be developed residentially and/or commercially for the benefit of a limited number of people. Moreover, these beneficiaries would generally exclude those who are the most interested in preserving the aesthetic and ecologic attributes of the area.

Of the alternative dam sites given preliminary consideration in selecting the monetarily optimum site, only two sites, at mile 4.2 and mile 5.6, could be considered rational alternatives. Without regard to engineering feasibility, a dam at mile 4.2 could provide a reservoir which would preserve nearly all of the contracted gorge area and Rhododendron Hollow and which would provide project operational efficiency for all purposes served similar to the downstream site. However, a dam and appurtenant works would be difficult to adapt to this site. Because of the scope and depth of engineering studies which would be necessary to achieve a workable design, cost estimates were not prepared for the site at mile 4.2. Because of the design disadvantages of this site, the construction costs could be expected to be substantially greater than the costs for the downstream site.

The alternative site at mile 5.6 is more suited, structurally, to a dam and appurtenant works, assuming reasonable foundation conditions, than the other alternative site at mile 4.2. It would be located at the glacial divide where bedrock appears to be closest to streambed. With a dam at this site, there would be no ecological losses due to inundation of the valley. However, the influx of visitors, and the press for private commercial and residential development would have an adverse impact on the downstream area. Since the principal area of ecological and aesthetic value lies between the mouth of Clear Creek to just above Rhododendron Hollow at mile 4.1, this site at mile 5.6 would be one mile removed from the area to be protected. The advantage of preserving the natural environment afforded by the upstream site could not be achieved unless all the area to be protected downstream were brought under public ownership. For continuous public ownership from the upstream site to the downstream limit of the nature area, some 6,500 acres would require acquisition, or 2,700 acres more than for the site at mile 3.1. A comparison of land allocation and visitation of the downstream and upstream dam sites indicates that the lower site at mile 3.1 will have a definite advantage over the upstream site for recreational development. Due to the presence of two sizeable tributaries, the downstream pool has considerably more usable recreation land, even though the surface areas are comparable. Table 15-5 compares potential land and water usage and visitation for the two sites.

TABLE 15-5
COMPARISON OF RECREATION LAND AND WATER AND VISITATION
BETWEEN ALTERNATIVE PROJECTS

Pool	Downstream Mile 3.1	Intermediate Mile 4.2	Upstream Mile 5.6
Elevation	854.0	859.5	859.5
Surface Area (Acres)	1,825	2,097	1,825
Unrestricted Boating	868	913	918
Restricted Boating	925	1,145	868
Swimming	32	39	39
Project Lands (Acres)			
Recreation Lands 1/			
Water Oriented 2/	2,954	2,634	1,860
Upland 3/	1,375	1,715	986
Scenic Buffering 4/	4,906	3,821	4,904
Wildlife Lands	2,615	4,000	4,000
Nature Area	3,800	4,700	6,550
Total Lands 5/	±15,650	±16,870	±18,300
Estimated Recreation Potential (User Days)			
Zone of Water Enhancement	2,650,000	2,365,000	1,670,000
Upland Potential	1,235,000	1,540,000	885,000
Nature Area	120,000	160,000	222,000
Fish and Wildlife	44,000	44,000	44,000
Allocation of Project Lands, Percent by Use			
Conservation and Preservation	41%	51%	57%
General Recreation	28%	26%	16%
Scenic Buffering	31%	23%	27%

1/ Lands of 15% slope or less.
2/ Recreation lands within 1/4 mile of reservoir.
3/ Project recreation lands more than 1/4 mile from reservoir.
4/ Lands greater than 15% slope, not utilized for general recreation.
5/ Includes joint use lands.

The majority of the additional acquisition would be solely for the purpose of integrating the reservoir project with the principal area to be preserved. Otherwise, the nature area would be completely detached from the reservoir project. Because of the greatly increased costs for acquisition and because of the distance of the upstream site from the principal area to be protected, the expenditure of Federal funds for project related preservation would not appear to be justifiable. Should the upstream site be selected, non-Federal interests would have to bear all costs for the nature area, including the costs for all land acquisition and all enhancement facilities.

These factors involving non-Federal costs for the upstream project bear upon the total economics of the project because the State had indicated that it cannot and will not incur this heavy, additional expense. Therefore, there would be no financial source for providing preservation with the upstream site. Assuming, however, that the necessary acquisition and enhancement could be achieved through some means, there are several additional consequential factors to be considered.

The cost of the water project, exclusive of the preservation lands and facilities would be substantially greater than the corresponding cost for the downstream site. The costs estimated for the upstream site are based on conservative assumptions which would reflect the least probable cost. Such assumptions included the assumption of ideal foundation conditions. Any conditions other than ideal could only increase costs. The net benefits for the upstream site (excluding any monetary value for not inundating a portion of the gorge) could not be greater than the benefits for the downstream project. Through this approach, the benefit-to-cost ratios and net-benefit analyses were reduced to a quantitatively sound, economic basis.

The quantitative economic disadvantages of the upstream site combined with other adverse consequential factors were then weighed against the social, aesthetic, and scientific value to be placed on averting inundation of that portion of the valley between the upstream and downstream sites and below the flood control pool elevation. There is considered to be no rational means of placing a realistic monetary value on the protection of this area.

Thus, comparisons were based on a composite of tangible <u>and</u> intangible values. These comparisons are discussed in the following paragraphs.

The cost of a project at mile 5.6 would be about $1.8 million more than that for a project at mile 3.1 and would include an increase of about $1.4 million for the dam and appurtenant works and $500,000 for non-preservation real estate, combined with a net decrease in several other items of about $100,000. These comparisons are for functionally equivalent projects with the exception that the upstream site controls ten percent less drainage area, which would tend to increase

drawdown of the recreation pool during the recreation season and would decrease the effectiveness of the reservoir in reducing flood heights along the Hocking and Ohio Rivers. The increase in real estate costs is attributable principally to the greater unit value of the flat, developable lands added in the upper end of the project, near Amanda. If not usurped for reservoir purposes, these added lands would be highly suited to accommodating residential development as the Columbus metropolitan area expands through Fairfield County over the next several decades.

When the added costs for preservation lands for the upstream site of about $1.1 million are added to the increased costs for the dam construction and non-preservation real estate, the total difference in first costs between the two projects would be about $2.9 million excluding any costs for additional items of enhancement facilities for the upstream project. The difference in annual charges including interest and amortization on construction costs, annual operation, maintenance and major replacements, and annual economic costs for loss of real estate productivity, would average at least $120,000. At an interest rate of 3.25 percent per annum, this total annual charge represents a present worth of about $3.6 million.

Summarizing the consequential factors involving the alternative dam site at mile 5.6, the project would be about one mile removed from the gorge; would require 2,700 acres additional acquisition for preservation alone; would cost at least $120,000 annually more than the downstream site; would provide a substantially reduced justification for Federal expenditure for preservation; would result in reduced project efficiency for water supply, water quality control and flood control because of the reduced drainage area; would reduce the quality of general recreation usage because of the elimination of the larger tributary areas of the reservoir; and would result in a decreased economic expansion effect within Appalachia.

The State of Ohio has formally requested that the downstream site be evaluated and reported upon. In view of this request and the alternative considerations, the downstream site at mile 3.1 was selected for detailed analysis.

9. THE SELECTED PLAN FOR LOGAN DAM AND RESERVOIR

General design features - In the selected scheme, Logan Dam and Reservoir would be located 3.1 miles above the mouth of Clear Creek and would control a drainage area of 84.1 square miles. A reservoir map for the project is shown on exhibit 15-3. The reservoir would have a total storage capacity of 78,000 acre-feet. Of this total, 35,900 acre-feet would be for flood control, 7,200 acre-feet would be for water quality control, 29,900 acre-feet would be for water supply, and

5,000 acre-feet would constitute the sediment pool. The normal pool, which includes the sediment pool, water supply and water quality storage, and having a maximum surface area of 1,825 acres, would be utilized for recreation.

Real estate to be acquired for the project would amount to 15,650 acres including 3,800 acres for the Clear Creek Nature Area. Relocations and changes in utilities would involve five miles of county and township roads, 20 miles of power, telephone and pipe lines, and two cemeteries.

Data on the reservoir pools are shown in Table 15-6.

TABLE 15-6
RESERVOIR POOL DATA

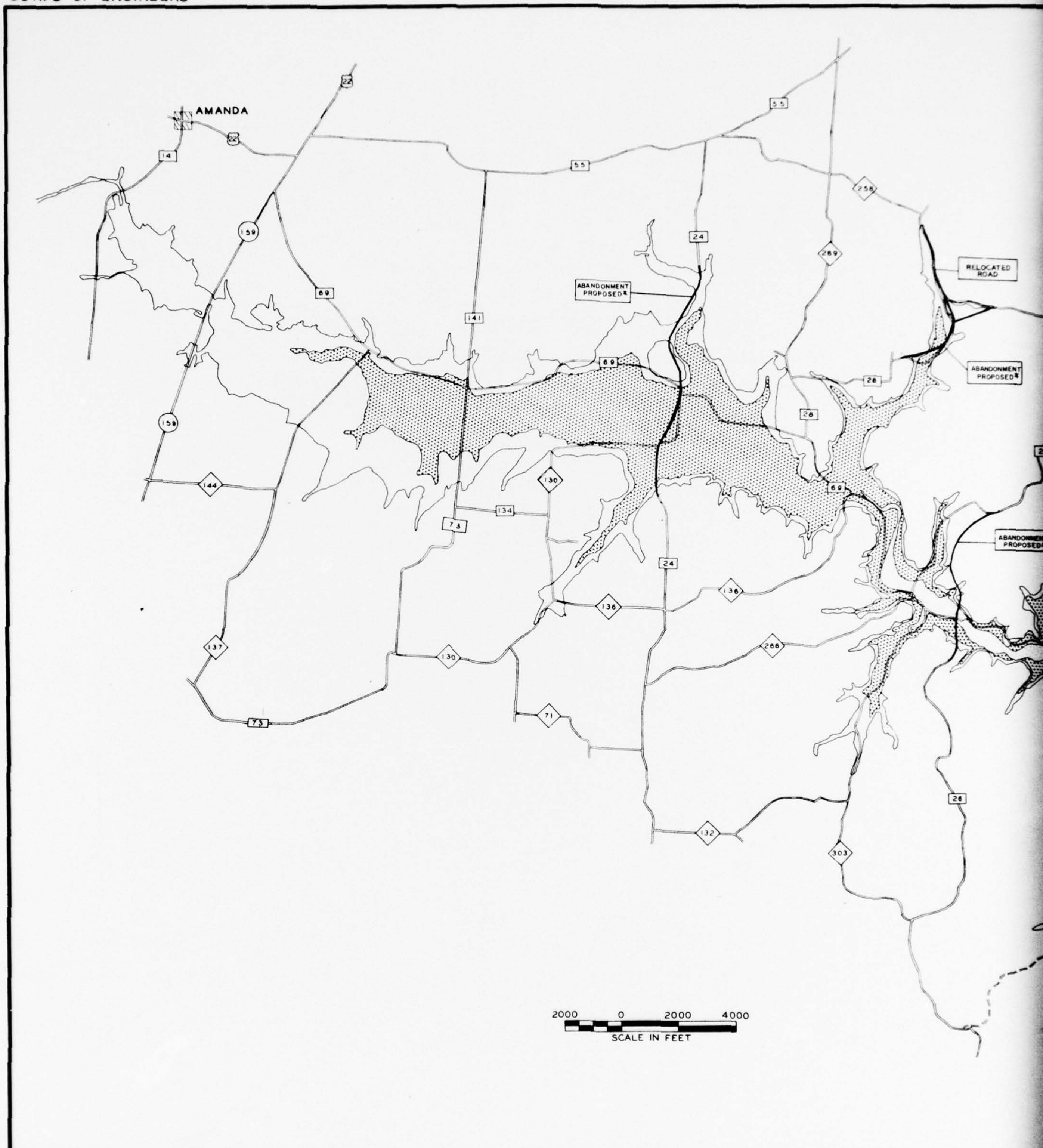
Pool	Surface elevation	Capacity: Acre-feet Net	Capacity: Acre-feet Accum.	Capacity: Inches Net	Capacity: Inches Accum.	Pool area, Acres
Minimum	813	5,000	5,000	1.1	1.1	312
Normal 1/	854	37,100	42,100	8.3	9.4	1,825
Water supply		29,900		6.7		
Water quality control		7,200		1.6		
Flood Control	868.3	35,900	78,000	8.0	17.4	3,100
Total	868.3	78,000		17.4		3,100

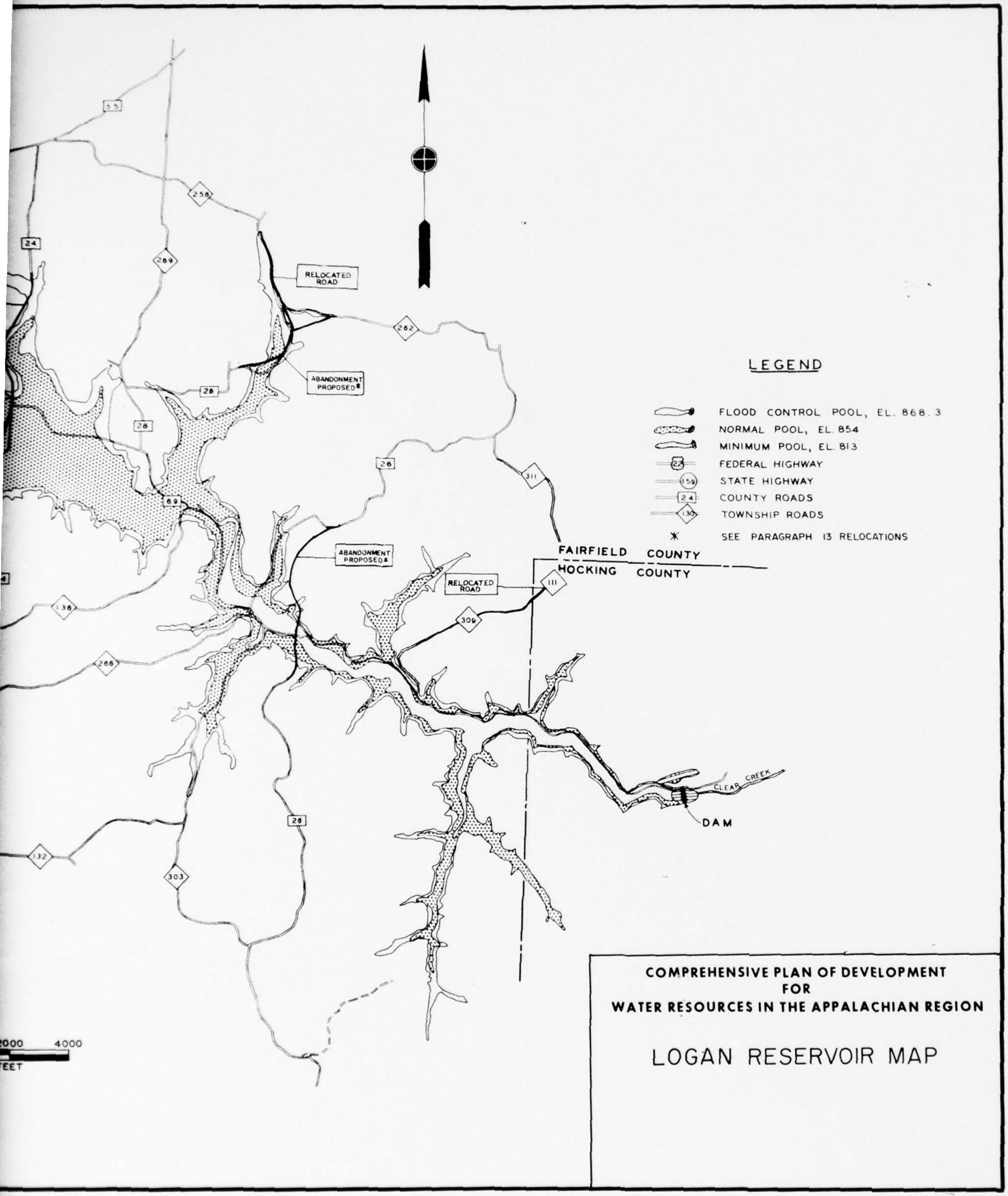
1/ Surface of normal pool would be used as the recreation lake.

Flood control. The flood control feature of the project will be operated to reduce flood stages on the Hocking River and Ohio River. For example, the reduction effected at Athens for a flood equal in magnitude to the 1964 flood (34-year frequency), would be 0.8 foot in addition to the 3.3 foot reduction attributed to the Local Protection Project. For a flood with a frequency of occurrence of once in a hundred years, the reservoir would reduce the stage 0.8 foot in addition to the 2.7 feet reduction effected by the Local Protection Project.

Water quality control. The water quality control storage will be utilized to maintain a minimum flow of 15 c.f.s. in Clear Creek. After year 2020, additional flow augmentation will be provided during the months of August and September to maintain minimum flows in Clear Creek of 28 c.f.s. and 29 c.f.s., respectively. Fishery requirements downstream of the dam, and a significant portion of the water quality needs in the Hocking River, with the exception of the mine drainage problem, will be satisfied through year 2070. Future water quality needs in the mainstem Hocking River should be further defined at such time as advance engineering and design studies are undertaken.

CORPS OF ENGINEERS





COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

LOGAN RESERVOIR MAP

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<u>Water supply</u>. The water supply storage will insure a supply of 24 million gallons per day. Water for municipal and industrial supply would be pumped directly from the reservoir over the Clear Creek - Upper Hocking River divide, and then would flow by gravity to the treatment plant at Lancaster, for a distance of about 7.5 miles.

<u>Development and enhancement of recreation potential</u>. The selected project would be located within a scenic area of southeastern Ohio. Exhibit 15-4 shows its location with respect to the Hocking Hills region. Clear Creek and its gorge are known throughout the State for their unique aesthetic and botanical attributes. The dam would be built in the gorge about three miles above its lower end. The reservoir would not entirely inundate the remaining reach of the gorge.

Between dam site 3.1 and a point 800 feet upstream from the mouth of Rhododendron Hollow, or out of the confines of the gorge, approximately one hundred acres of vegetation lie within the proposed flood pool. In comparison, the area downstream of the dam site and below a comparable elevation extending to the mouth of Clear Creek includes 772 acres of land, much of it similar to Rhododendron Hollow. On this basis, and recognizing that features of ecological and scientific value are on or near the valley floor, less than 12 percent of the valley area will be lost to inundation, while the remainder above the dam will be aesthetically enhanced by the waters of the lake. The 1,825-acre recreation lake would be maintained 79 feet above the valley floor at the dam. The surrounding ridge lines range up to 400 feet above stream bed. In the upper end of the gorge, the normal pool would cover the valley with about 30 feet of water. The shoreline would lie along many rock-ribbed and tree-covered bluffs in the gorge. Lesser slopes would be encountered in the numerous lateral arms providing access to shaded coves and wooded hollows. The upstream two-thirds of the reservoir spreads out into gently rolling, glaciated farmland.

The recreation potential of a reservoir project is measured by the expected annual visitation, assuming a recreation development which is within the physical capacity of the site and appropriate to the demonstrated needs within the market area.

The physical capacity of the project is determined by such factors as areas of boating waters, swimming beach, and recreation lands; the ecology of the site; access to the site; the character of the site to the extent that it affects the kinds of activities possible at the site; and intensity of development desired or planned for the recreation land.

Present and projected recreation demands as determined by the Bureau of Outdoor Recreation, within the project area zone of influence, will exceed the carrying capacity of the project if it is developed to a high quality of recreation standards; therefore, a methodology

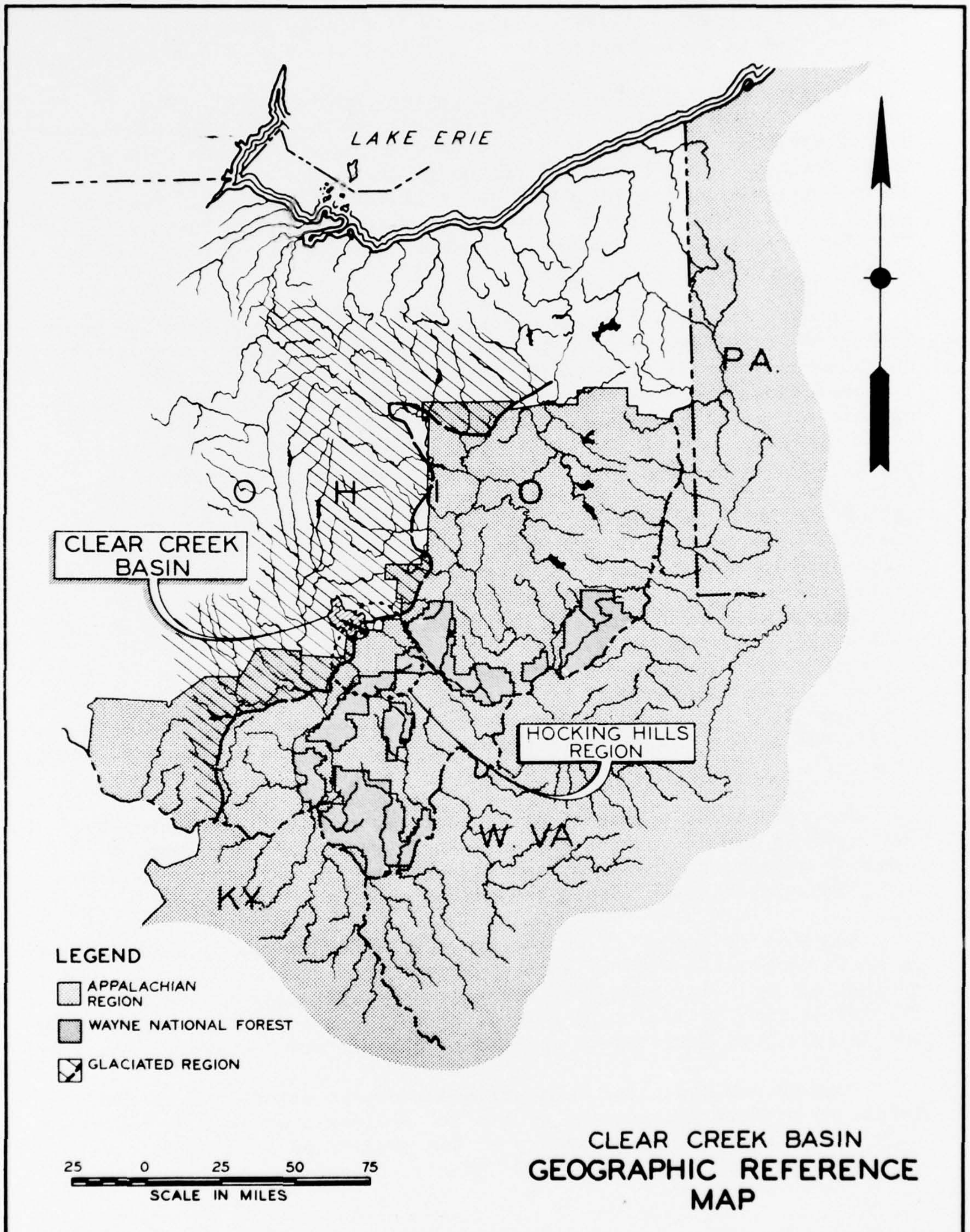
LAKE ERIE
PA.
O H I O
CLEAR CREEK BASIN
HOCKING HILLS REGION
W. VA.
KY.
LEGEND
APPALACHIAN REGION
WAYNE NATIONAL FOREST
GLACIATED REGION
25 0 25 50 75
SCALE IN MILES
CLEAR CREEK BASIN
GEOGRAPHIC REFERENCE MAP

EXHIBIT 15-4

based upon the carrying capacity of water-oriented recreation lands and surface area of the reservoir was used to determine annual project visitation.

The land area was measured, and a high quality of development represented by a visitation of ten persons per acre of water-oriented recreation land per year was assumed. The high quality development is further indicated in the facility design of: four picnic tables per acre, four campsites per acre, fifty square feet of beach per swimmer, 70 percent of bathers on the beach at any given time, five acres of water per boat, four persons per boat, etc.

All of the water-oriented recreation lands (about 3,000 acres) would be developed. If future expansion should become necessary, the upland recreation lands (about 1,400 acres) could be developed and the intensity of development on water-oriented lands could be increased, thus more than doubling the capacity of recreation lands. The developed water-oriented recreation land would represent only 25 percent of total project lands, exclusive of the Nature Area.

Percentage composition of projected visitation to the project compares favorably with the participation rates used in the Ohio Outdoor Recreation Plan as follows:

Activity	Percent	Design Load
Swimming	22	6,500
Picnicking	19	5,600
Camping	11	3,200
Boating	8	2,200

The four major outdoor recreation activities; swimming, picnicking, camping, and boating were used for purposes of this report to determine preliminary cost estimates. There are, of course, other activities in which recreationists participate at an impoundment. Four of the most important are: water skiing, nature walks, hiking and sightseeing. Although these activities are not of primary interest to as many people, most people do participate in one or more at some time during their outing and regardless of the adequacy of the supply for these "perished activities" elsewhere in the market area they will always be provided for in any water-oriented development.

A primary visitor turnover rate of 1.5 was used in determining facilities needed, and a capacity day was determined to be 1.6 percent of annual visitation. It was estimated that 80 percent of annual visitation would occur during the 16-week recreation season. Recent studies also indicate that recreation occasions on a normal summer Sunday constitute 33 percent of the weekly visitation, and presently recognizes three capacity days of usage per week on a project. Project capacity day usage is projected

to increase about 30 percent every twenty years, based upon 1960 data, giving four capacity days of usage in 1980, and five capacity days usage in the year 2000. It is felt that the estimated 2,652,000 annual visitors to the project is a realistic projection as determined within the framework of this report.

Lands of 15 percent or less slope are utilized for recreation. Lands with greater slope are integrated as scenic buffer areas. Water-oriented recreation lands are contiguous to and within one-fourth mile of the reservoir. Upland recreation lands are located more than one-fourth mile from the reservoir. Wildlife lands are those specifically devoted to wildlife management.

The development plan for Clear Creek State Park constitutes a complete recreational complex. Facilities would include a lodge and dining hall, vacation cabins, swimming beaches, boat launching ramps and docking areas, and provisions for sightseeing, picnicking, and tent and trailer camping. Upstream lands will be managed for wildlife, and fishing access areas will be provided downstream.

The recreation potential of the Hocking Hills region would be greatly enhanced with the addition of a water-based recreation area which, as noted in BOR's Ohio National Recreation Areas Feasibility Study, is conspicuously needed.

The lake level would remain relatively stable. Near the end of the prime recreation season, three feet of drawdown would occur about once in 10 years. After the year 2020, slightly greater drawdown would occur as increasing demands for water supply and low-flow augmentation for water quality control are met. Only under unusually severe and infrequent drought conditions would drawdown adversely affect recreation usage.

All construction scars, borrow areas and quarries would be restored by landscaping, seeding and planting. Facilities at all recreation sites would be designed to blend with the surroundings and all sites would be suitably landscaped. Access roads and relocations would be designed to accommodate project purposes and in a manner which would not detract from the natural scenery. Extensive use would be made of native rock in lieu of concrete or less attractive materials. The costs for beautifying various project features have been incorporated into the appropriate items in the detailed estimate of costs.

Clear Creek Nature Area. The plan for preservation and enhancement of the aesthetic and ecologic environment of Clear Creek Valley includes about 3,800 acres downstream of the dam. The nature area will have a Resident Outdoor Education Center, a Nature Interpretive Center, the Neotoma Ecological Research Area, and about ten miles of hiking and nature trails. The plan would insure permanent preservation of three miles of Clear Creek Valley, including Neotoma Valley,

and would permit intelligently controlled public usage. The nature area would be the allied interpretive facility of Clear Creek State Park. The overnight and day-use facilities of the recreational complex would greatly enhance the value of the nature area.

Present usage of the proposed Clear Creek Nature Area is beginning to deteriorate the ecological eminence of the area. If left in private ownership, the area may be subjected to over use and may be subdivided out of existence for vacation homes and camp sites by the nearby growing metropolitan population which is seeking temporary escape from the city. Public ownership would prevent development and over use and insure protection of the area forever.

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SECTION III - DESIGN CONSIDERATIONS

10. HYDROLOGIC

Physical characteristics of drainage basin. The Hocking River rises in Fairfield County and flows 99.4 miles in a southeasterly direction and enters the Ohio River at Hockingport in the southwest corner of Athens County. Exhibit 15-1 shows the location of the Hocking River Watershed with respect to the Ohio, Scioto and Muskingum Rivers.

The total area of the Hocking River Basin is 1,200 square miles. The basin is roughly rectangular in shape, and has an average width of approximately 25 miles, and an average northwest-southeast length of approximately 70 miles. Table 15-7 lists drainage areas of the Hocking River and principal tributaries.

The topography of the Hocking Basin is generally hilly with moderately steep slopes except in the glaciated headwater area. The basin includes a large portion of Fairfield County and small portions of Hocking and Perry Counties, and is characterized by low, gently sloping hills and broad flat valleys. Elevations above mean sea level range from 552 feet (approximate low water) at Hockingport to approximately 1,100 feet at the head of Clear Creek in Fairfield County. There are no natural bodies of water in the basin. Principal existing lake areas consist of Tom Jenkins Reservoir constructed by the Corps and having a surface area of 664 acres at water supply pool level, and State-constructed Hocking, Dow and Clouse Lakes having surface areas of 400, 160, and 49 acres, respectively. The major portion of the lands in the flood plains are devoted to agriculture for which the soil and topography are generally good. In the basin, the farm land accounted for slightly over 50 percent of total lands. Commercial clays and coal deposits are widespread throughout the basin and a considerable portion of the basin occupancy has been in connection with the development of these resources.

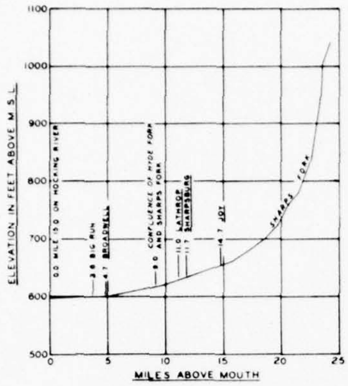
Stream characteristics. The Hocking River follows a winding course and flows in a channel rarely exceeding 100 feet in width except near the mouth where the width between banks is approximately 200 feet. The bottom lands along the stream are generally flat and cultivated, averaging about one-half mile in width, and are bounded by hills of moderately steep slopes. The banks range in height above low water from 5 to 10 feet at Lancaster near the head of the stream to 15 to 20 feet near the mouth. The total fall of the main stream is 434 feet, or from elevation 1000 at the extreme headwater to elevation 564.5 (normal pool of Lock and Dam No. 20 - Ohio River) at the mouth, or an average slope of 4.6 feet per mile. Streambed profiles of the Hocking River and major tributaries are shown on Exhibit 15-5.

TABLE 15-7

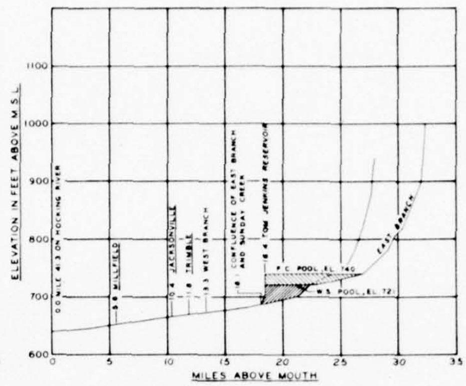
DRAINAGE AREAS OF HOCKING RIVER AND PRINCIPAL TRIBUTARIES

Stream	Location	Miles above mouth of Hocking River	Drainage area sq. mi.	Average slope, ft./mi.	Length in miles to headwaters
Hocking River	At Lancaster Gage	83.7	49.8	-	11.2
Little Rush Cr. 1/	At mouth	94	61.4	8.1	18.0
Rush Creek	At mouth	79	235	8.4	35.5
Hocking River	Below mouth of Rush Cr.	79	328	-	20.4
Clear Creek	At mouth	77	91.8	15.0	22.6
Hocking River	Below mouth of Clear Cr.	77	427	-	22.4
Hocking River	At Enterprise Gage	71	460.	-	28.4
Scott Creek	At mouth	66.7	39.8	15.0	9.5
Hocking River	Below mouth of Scott Cr.	66.7	502	-	32.7
Monday Creek	At mouth	47.2	116	10.4	30.5 2/
Hocking River	Below mouth of Monday Cr.	47.2	703	-	52.2
Sunday Creek	At mouth	41.3	139	11.5	27.9
Hocking River	Below mouth of Sunday Cr.	41.3	852	-	58.1
Hocking River	At Athens Gage (Mill Street)	31.9	944	-	67.5
Federal Creek	At mouth	15.0	145	19.1	23.8 3/
Hocking River	Below mouth of Federal Cr.	15.0	1143	-	84.1
Hocking River	At mouth	0.0	1200	4.6	99.4

1/ Tributary of Rush Creek
2/ Includes Little Monday Creek
3/ Includes Sharps Fork



FEDERAL CREEK



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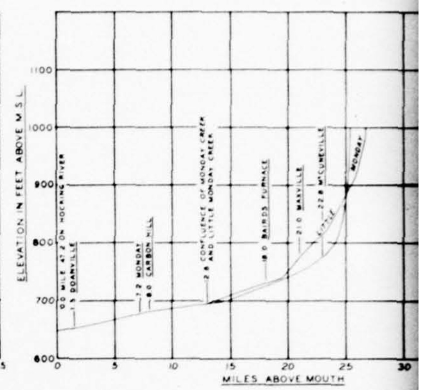

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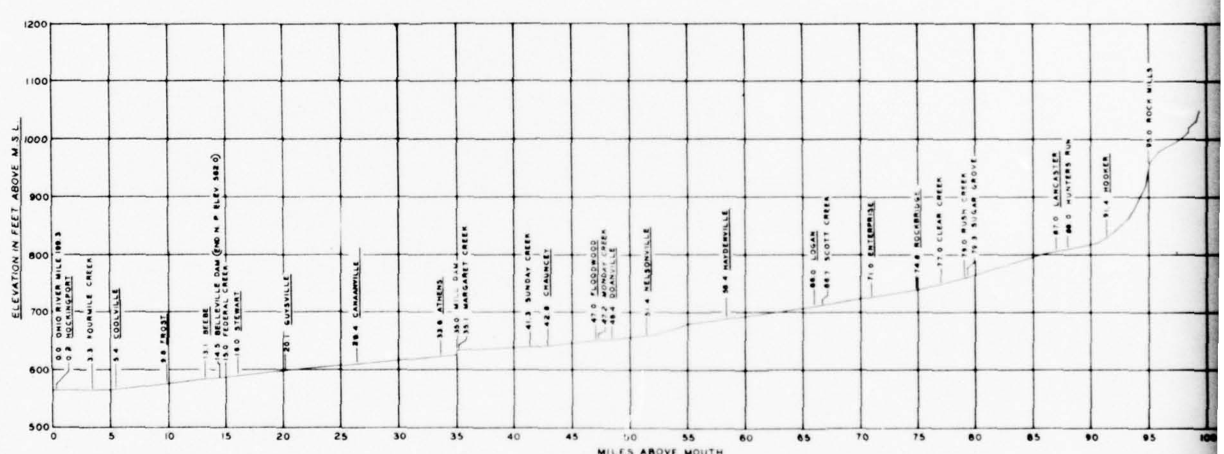
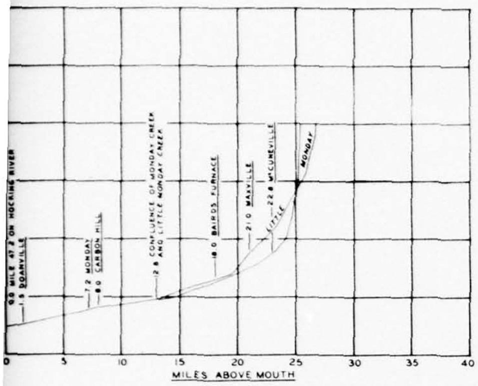


HOCKING RIVER



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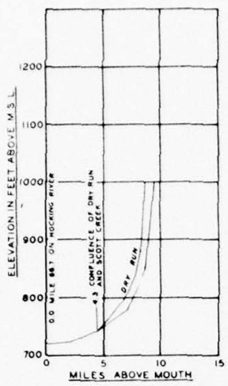

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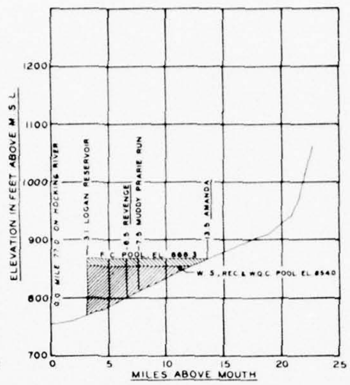
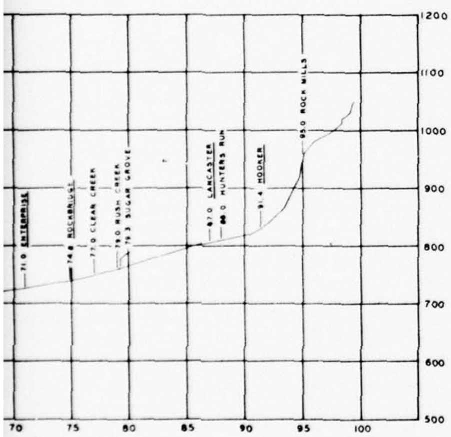
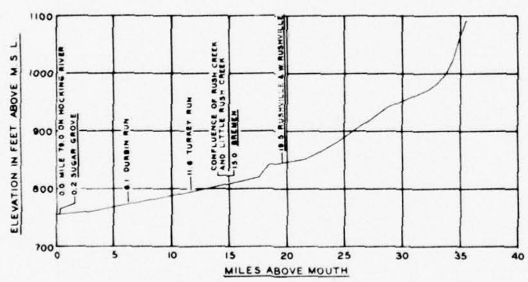


CLEAR CREEK





RUSH CREEK

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
HOCKING RIVER BASIN
OHIO

STREAM PROFILES

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General climatology. The climate of the basin is typical of the central temperate zone, having highly variable temperatures and non-seasonal precipitation which varies from year to year and from month to month. The basin is affected by frontal air-mass activity, and is subject to both continental polar and maritime tropical air masses. Frequent and rapid changes in weather occur, due to the passage of fronts associated with general low-pressure areas. The prevailing wind direction is from the southwest.

Climatological records. Meteorological data are available from 17 stations within the basin and from numerous stations adjacent to the area. The locations, periods of record and average annual data are given in Table 15-8 and the distribution throughout the area is shown on exhibit 15-1.

Temperature. The period of record within the basin extends from 1883 to date. Temperatures recorded at stations located in the basin have ranged from a minimum of -24 degrees Fahrenheit at Amesville on 21 January 1918 to a maximum of 110 degrees at Amesville on 6 August 1918. The mean annual temperature for the entire basin is approximately 53 degrees. The growing season, or the period between the last killing frost of spring and the first killing frost of autumn, is approximately 160 days, and extends from mid-May to mid-October. Average annual temperatures for individual stations, where available, are listed in Table 15-8. Normal monthly and annual temperatures for representative stations are listed in Table 15-9.

Precipitation. Precipitation records, within the basin, were initiated in 1883. The normal annual precipitation over the basin averages approximately 37.3 inches and is listed for individual stations, where available, in Table 15-8. Average, maximum, and minimum monthly and maximum 24-hour precipitation for selected stations are listed in Table 15-9. The average annual snowfall over the basin is about 18.0 inches and represents only a minor portion of the total annual precipitation. Average annual snowfall for individual stations, where available, is listed in Table 15-8. Average monthly snowfall for representative stations is listed in Table 15-9. The basin lies directly in the path of extensive meteorological disturbances which in winter and spring generally travel from southwest to northeast and pass over the basin. Two distinct types of storms result in floods, that is, summer and winter-type storms. The summer-type usually occurs during the period May to October, inclusive, and is characterized by rainfall of high intensity, short duration, and relatively small areal extent. The winter-type storm usually occurs during the period December to March, inclusive, and is characterized by less intense rainfall of extensive duration and large areal extent, often affecting several states. The winter-type storms are generally caused by the interaction of cold air masses originating in the region of Alaska,

TABLE 15-8

METEOROLOGICAL STATIONS IN AND NEAR THE HOCKING RIVER BASIN

Station		Period of Record	Equipment 1/	Average Annual Temp.	Average Annual Precip.	Average Annual Snowfall
Amesville		1954-date	NR		39.80	2/
Athens		1896-date	R,T	53.9	39.55	16.3
Beverly	3/	1913-1952	R		39.14	14.4
Circleville	4/	1888-date	R,T	53.5	39.10	15.0
Columbus	4/	1879-date	NR,R,T	52.1	35.50	20.3
Enterprise		1948-1952	NR		44.22	12.7
Gratiot	5/	1890-1913	NR		39.89	2/
Lancaster 2NW		1957-date	NR		34.36	2/
Lancaster		1896-date	R,T	52.3	40.30	20.8
Lancaster 5WSW		1957-date	R		35.71	2/
Lancaster 2W		1957-date	NR		35.95	2/
Lancaster 5WNW		1957-date	R		35.22	2/
Lancaster 6N		1957-date	NR		37.73	2/
Lancaster 6W		1957-date	NR		36.37	2/
Logan		1883-1923	R		41.05	2/
Marietta	3/	1818-date	R,T	53.6	41.70	15.0
McArthur	6/	1892-1944	R,T	52.9	40.63	17.0
McConnelsville	3/	1884-date	NR,T	52.6	40.25	23.9
Milligan	3/	1893-1923	NR		39.23	2/
New Lexington		1943-date	R,T	51.6	37.00	25.1
Somerset		1897-1919	R		37.95	2/
Tom Jenkins Dam		1951-date	R,T		34.20	2/
Valley Crossing	4/	1916-1930	NR,T	52.1	37.15	20.0
Walnut	4/	1893-1903	NR		35.34	2/
Zanesville	3/	1889-date	R		37.43	19.8

1/ NR: Non-recording precipitation gage
R: Recording precipitation gage; also usually equipped with non-recording gage
T: Thermometer, Maximum and Minimum

2/ Insufficient data available to determine value

3/ Muskingum River Basin

4/ Scioto River Basin

5/ Licking River Basin

6/ Raccoon Creek Basin

TABLE 15-9

CLIMATIC SUMMARY

Station	Years of record	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
							Normal monthly and annual snowfall-inches							
Athens	30	4.8	4.2	2.6	0.1	0	0	0	0	0	0	2.0	3.3	17.0
Lancaster	65	5.8	5.1	2.6	0.8	0	0	0	0	0	0.1	1.8	4.6	20.8
							Normal monthly and annual temperature-degrees F.							
Athens	27	33.0	34.7	42.1	54.1	62.7	71.3	74.7	73.4	67.2	55.8	43.8	34.3	53.9
Lancaster	63	31.0	31.9	41.2	51.2	61.6	69.9	73.9	72.2	66.2	53.7	42.2	32.8	52.3
							Normal monthly and annual precipitation-inches							
Athens	48	3.54	2.84	3.47	3.28	3.73	4.10	4.32	3.80	2.81	2.30	2.80	2.68	39.67
Lancaster	66	3.38	2.67	3.98	3.53	3.92	4.26	4.19	3.57	2.80	2.36	2.71	3.02	40.39
							Maximum monthly and annual precipitation-inches							
Athens	48	10.11	6.27	6.41	6.78	10.64	9.91	11.89	8.89	6.71	6.49	6.78	6.56	52.02
Lancaster	66	12.59	7.06	9.95	7.74	7.86	8.89	10.67	8.33	7.33	6.76	6.88	8.03	53.25
							Minimum monthly and annual precipitation-inches							
Athens	48	.70	.55	1.07	1.21	.70	.48	1.38	.68	.31	.17	.49	.64	22.28
Lancaster	66	.76	.45	.10	.80	.54	.72	1.06	.38	.55	.16	.20	.84	23.65
							Maximum 24-hour precipitation-inches							
Athens	48	2.48	2.17	2.29	3.10	3.34	3.34	3.64	3.43	4.35	2.28	1.50	2.46	4.35
Lancaster	66	2.00	1.88	3.46	2.65	2.72	3.16	2.82	3.06	5.89	3.04	2.31	1.75	5.89

with warm moist air masses sweeping northward from the Gulf of Mexico and southern Atlantic Ocean. Occasional stagnation and stationary development produce prolonged precipitation. Snow cover, saturated or frozen ground, or combination thereof, may greatly increase runoff rates and volumes. Storms of convectional, or, "thunderstorm," type are also prevalent over and near the Hocking Basin. The greatest recorded precipitation in the Hocking Basin for a period of one day or less occurred at Logan during the storm of 18-19 July 1889, when a total of 6.06 inches of rain fell in 18 hours, 5.50 inches falling in a period of 3.5 hours. Other intense rainfalls in the basin from summer-type storms include 3.45 inches of rain in three hours at Logan on 26 August 1890; 3.16 inches in two hours at Lancaster on 13 June 1902; and 5.40 inches at Lancaster on the night of 12 September 1938, when an average of more than five inches of rainfall was experienced over the upper third of the Hocking Basin in a period of about five hours. The greatest winter-type storms in the basin were those of 23-27 March 1913, when average rainfall above Athens totaled 5.43 inches, and 12-14 March 1907, when average rainfall above Athens totaled 5.51 inches. The latter storm produced the maximum flood of record. In the storm of 16-17 June 1950 which occurred in the Crooksville area of Ohio, the rainfall was of cloudburst variety and rainfall intensities of 2.3 inches in one hour and 4.1 inches in two hours were recorded. The maximum unofficial rainfall was about twice the total recorded at Crooksville, and it is logical to estimate that the maximum intensities also were approximately double those for the Crooksville gage, or 4.6 inches in one hour and 8.2 inches in two hours. Such storms are generally of a local character and seldom produce major floods over extensive areas.

Runoff. Basin runoff is highest during the winter months when storm rainfall may be augmented by snow melt and when frozen or saturated ground results in low infiltration rates. Runoff is lowest in late summer and early fall when the ground is dry and losses are highest. The mean annual runoff of the Hocking River and its tributaries has averaged slightly more than 1.0 cubic foot per second per square mile of drainage area during the period of record at Athens. Table 15-10 presents monthly and annual runoff data for the Hocking River at Athens and Enterprise.

Stream flow records. The United States Geological Survey maintains and operates six stream gaging stations in the Hocking River Basin and has operated the recording stream gage at Athens, Ohio since 1915. Pertinent data for this gage and the other gages in the basin are given in Table 15-11. This station has been rated by discharge methods only to moderately high states, necessitating extension of the rating curve for studies of major floods.

TABLE 15-10

MONTHLY AND ANNUAL RUNOFF
HOCKING RIVER AT ATHENS AND ENTERPRISE

Years of Record - 46 Athens, 31 Enterprise   Drainage Area - 943 Square Miles Athens, 460 Square Miles Enterprise

Month	Mean Monthly and Annual Runoff in Inches		Maximum Monthly and Annual Runoff in Inches		Minimum Monthly and Annual Runoff in Inches	
	Enterprise	Athens	Enterprise	Athens	Enterprise	Athens
January	1.75	1.98	9.04	9.52	0.14	0.09
February	1.72	1.93	3.70	4.33	0.13	0.10
March	2.24	3.26	7.21	6.41	0.34	0.32
April	2.00	2.00	5.40	5.04	0.45	0.46
May	1.33	1.48	3.71	4.15	0.24	0.21
June	0.83	0.88	2.70	3.72	0.17	0.09
July	1.02	0.62	11.34	3.61	0.15	0.06
August	0.52	0.48	3.09	2.73	0.10	0.05
September	0.33	0.37	1.34	2.25	0.07	0.05
October	0.21	0.25	0.48	1.59	0.07	0.04
November	0.35	0.57	1.10	3.77	0.09	0.05
December	0.87	1.19	3.12	4.68	0.12	0.08
Annual	13.17	15.01	19.30	22.13	3.23	3.35

Flood records. The earliest flood for which any specific data could be obtained occurred in 1873. Old newspaper accounts indicate that major floods occurred at Athens in 1832, 1847, 1852, 1858, and 1859. The greatest flood of record for which more or less complete information could be obtained occurred in 1907, and the highest flood occurring since collection of stage data was initiated was in March 1964. Enterprise and Athens have been selected for illustrating past flood conditions in the Hocking River Basin. Table 15-12 shows crest discharges and stages of all major floods at Enterprise since 1930 and at Athens since 1915 where such information is available.

Historic Storms and Floods.

Flood of July 1873. The flood of July 1873 is the only major flood of record having occurred in the Hocking River Basin during the summer months. It was caused by a steady downpour of rain which fell from Thursday, 3 July, until the following Saturday. This flood is one of the ten highest of record at Athens where an equivalent gage height of 23 feet was reached. The Hocking River Valley was damaged throughout its length with especially severe crop losses.

TABLE 15-11

U.S.G.S. STREAM FLOW RECORDS OF HOCKING RIVER AND TRIBUTARIES

Location	Miles above mouth	Drainage area, square miles	Period of record	Type 1/ of gage	Maximum 2/ stage, feet	Discharge, Cubic feet per second Maximum	Minimum	Mean
Hunters Run at Lancaster, Ohio	84.2	9.63	1956 to date	R	7.09	1,360	0.3	9.1
Hocking River at Lancaster, Ohio	83.7	49.8	1956 to date	R	15.36	3,420	2.3	39.7
Hocking River near Lancaster, Ohio	78.3	92.8	1923 to 1932		10.2	2,050	5.0	88.6
Hocking River at Enterprise, Ohio	71	460.0	1930 to date	R	21.31 3/	26,040	12.0	437.0
Clear Creek near Rockbridge, Ohio	75.6	87.7	1939 to date	R	17.68	16,000	3.0	84.8
Clear Fork near Logan, Ohio	65.2	14.8	1942 to 1947	R	11.1	4,440	0.4	17.1
Sunday Creek at Glouster, Ohio	52.4	104.0	1951 to date	R	17.8	7,020	0.4	97.7
Hocking River at Athens, Ohio	31.9	944.0	1915 to date	R	24.2 3/	33,000	9.0	982.0

1/ Latest type of gaging equipment at gage.
R - Recording gage

2/ Maximum stage and discharge during period of record; discharge estimates as furnished by USGS; stages for present site and datum

3/ Flood stage at Enterprise is 12.0 and 16.0 at Athens

TABLE 15-12

HIGH WATER DATA

Date		Hocking River at Enterprise, Damage stage 12.0 feet: Gage Ht., feet 1/	Discharge, c.f.s.	Duration, days 2/	Date		Hocking River at Athens, Damage stage 16.0 feet: Gage Ht., feet 1/	Discharge, c.f.s.	Duration, days 2/
15 March	1933	15.83	9,730	2.5	18 December	1915	18.56	12,600	1.5
29 July	1935	15.16	8,720	1.5	14 March	1918	18.48	12,400	0.8
27 February	1936	12.64	5,870	0.8	21 April	1920	19.72	15,800	1.3
22 January	1937	19.13	16,600	5.5	16 April	1922	22.49	25,400	2.6
24 May	1938	14.85	8,300	1.4	30 March	1924	19.15	14,100	1.8
17 April	1939	13.65	6,860	2.1	22 January	1927	18.95	13,600	4.1
20 April	1940	21.14	25,200	2.6	22 June	1928	18.87	13,400	1.6
4 June	1941	12.17	5,440	0.2	15 May	1933	20.37	18,000	2.6
10 April	1942	12.34	5,600	0.8	5 September	1935	20.17	17,300	2.0
20 March	1943	19.10	16,500	2.3	7 April	1936	18.74	13,100	1.3
6 March	1945	19.68	18,400	2.6	23 January	1937	23.35	28,700	5.9
19 June	1946	12.00	5,200	0.2	25 May	1938	19.31	14,600	1.6
13 April	1948	18.00	13,700	3.5	17 April	1939	19.61	15,500	3.1
28 January	1949	12.80	6,010	0.9	21 April	1940	23.64	30,000	3.1
7 January	1950	13.61	6,820	1.1	4 June	1941	19.52	15,200	2.0
15 January	1951	14.18	7,460	2.0	21 March	1943	20.94	20,000	2.3
27 January	1952	14.39	7,720	1.8	7 March	1945	23.72	30,400	2.8
5 March	1955	12.97	6,170	1.4	13 April	1948	22.52	25,500	3.9
5 April	1957	12.45	5,700	0.8	17 December	1948	18.68	12,900	1.5
22 January	1959	15.97	9,950	2.2	8 January	1950	18.80	13,200	2.0
8 May	1961	14.50	7,850	1.8	16 January	1951	21.63	22,400	2.5
28 February	1962	12.13	5,410	0.4	28 January	1952	18.80	13,200	1.8
6 March	1963	19.13	16,600	2.8	24 July	1958	18.60	12,700 3/	1.4
10 March	1964	21.31	26,040	3.0	23 January	1959	19.72	15,800 3/	2.7
24 May	1968	18.20	-	-	10 May	1961	19.68	15,700 3/	1.7
					28 February	1962	18.50	12,500 3/	1.8
					6 March	1963	23.10	27,700 3/	3.6
					11 March	1964	24.20	33,000 3/	3.7
					25 May	1968	24.60	-	-

1/ Gage heights referred to present USGS gages and latest ratings
2/ Duration above damage stage
3/ Modified by Tom Jenkins Reservoir

Flood of February 1884. The Ohio Valley flood of February 1884 resulted from moderately heavy general rains falling from 4 to 14 February, during a midwinter thaw. The average precipitation recorded over the Hocking River Watershed was 4.82 inches; 0.93 inches occurring on 6 February, the day of heaviest rainfall. The period of maximum rainfall was coincident with the culmination of the thaw on 5, 6 and 7 February. A flood crest of 24 feet corresponding to a discharge of about 35,000 c.f.s. was reached at Athens on 7 February, two days before the Ohio River crest at the mouth of the Hocking River. Bottom lands throughout the valley were submerged and the flood caused greater damages than had been previously experienced on the Hocking River.

Flood of March 1907. Damaging floods prevailed on the Ohio River and its tributaries during the middle ten days of March 1907. Serious damages resulted on all the streams in southern Ohio but probably the greatest havoc was wrought in the Hocking River Valley. The flood here was caused by unusually heavy rains and melting snow over the entire watershed. A light rain, accompanied by temperatures considerably above normal, occurred during the first eleven days of the month, melting the snow cover and saturating the ground. On 12, 13 and 14 March, excessive rains fell over the entire watershed, the total average rainfall over the area above Athens being 5.51 inches. The river rose rapidly to the highest stage ever recorded. At Athens, the flood reached a stage of 27.4 feet, equivalent to 26.7 feet on the present gage. This difference in stage is due to a correction of the datum of the benchmark used for referencing the high water mark. The estimated maximum discharge at Athens was approximately 50,000 c.f.s. This flood was the most destructive of record throughout the Hocking River Basin, and several lives were lost.

Flood of March 1913. The flood of March 1913 in the Ohio Valley was the result of unprecedented widespread rains falling generally over the States of Ohio and Indiana in a short period of time, when conditions were favorable for high runoff. The flood was augmented by previous lighter rains over the southern part of the basin which caused local streams to be at medium stage at the onset of the storm. Over a period of four days, from 23 to 27 March, the maximum rainfall recorded in the Hocking River Basin was 7.5 inches at Lancaster. The average rainfall for that portion of the basin above Athens has been estimated at 5.43 inches. The resulting flood generally paralleled the record flood of 1907, being 2.4 feet lower at Logan, 3.5 feet lower at Nelsonville, and 3.4 feet lower at Athens. The maximum stage of 24.0 feet on the Athens gage occurred on 26 March, three days before the crest on the Ohio River was reached at the mouth of the Hocking River. Property damage was heavy throughout the watershed but was not nearly as severe as in 1907. There is no record of loss of life during this flood.

Observed storms and floods.

General. Except at the Athens gaging station, which was established May 1915, there are no official records of past floods

occurring prior to 1931. However, numerous high-water marks have been established for the major floods, and elevations of various floods as early as 1873 have been determined from these marks. The greatest flood for which quantitative records could be obtained occurred in March 1907, and the greatest flood since measurement of discharges began occurred in May 1968 at Athens and in March 1964 at Enterprise. In view of the adequate amount of observed rainfall and runoff data available, it is not necessary to describe each individual flood for the past 47 years. A comprehensive account is given in the following paragraphs for the floods of January 1937, April 1940, March 1945, April 1948, March 1963, March 1964, and May 1968.

Storm and flood of January 1937. The Ohio Valley flood of January-February 1937 resulted from excessive rains during January which followed moderately heavy rains occurring in the latter part of December over the entire Ohio River Watershed. The total precipitation for January in the lower portion of the Ohio River Basin was more than four times the amount which normally occurs during the month. During the period 20 to 25 January, inclusive, the rainfall over the Hocking River Basin ranged from 4.45 inches at Athens to 7.05 inches at Lancaster with the maximum for any day being 2.0 inches at Lancaster. The resulting flood on the Hocking River was several feet lower than the maximum of record throughout the valley. A maximum stage of 22.7 feet, equivalent stage of 23.4 feet on the present gage, was reached at Athens on 23 January, three days before the crest on the Ohio River at the mouth of the Hocking River. No lives were lost and damage was much less severe than in other major floods. Low-lying sections of several towns along the main stream and principal tributaries were flooded and railroads and highways were inundated at various places.

Storm and flood of April 1940. The flood of April 1940 resulted from excessive rain falling over the entire drainage basin during the period 16 to 20 April, inclusive, when conditions were favorable for a large runoff due to pre-saturation of the soil from preceding moderate rains; The total precipitation during April was the third highest of record for the State of Ohio. The average precipitation over the Hocking River Basin amounted to 4.34 inches during the period 16-20 April, inclusive, ranging from 5.28 inches at Lancaster to 3.86 inches at Athens. The highest daily amount fell at Lancaster on the 19th, amounting to 2.72 inches. The resulting flood was the third highest since establishment of the Athens gaging station and the sixth highest of authenticated record. A crest stage of 22.9 feet, equivalent stage of 23.6 feet on the present gage, was reached at Athens on 21 April, one day ahead of the Ohio River crest at the mouth of the Hocking River. The greatest flood which has occurred in the memory of the inhabitants was experienced on Rush Creek. General flood conditions which prevailed throughout the Hocking River Basin resulted in serious urban and agricultural losses and damages to railways and highways at numerous points. Railroads were

forced to suspend operations for periods ranging from two to four days. Urban damages were most severe at Glouster and Athens. There is no record of loss of life during this flood.

Storm and flood of March 1945. The Ohio River Valley was the scene of a large flood during the first half of March 1945 as a result of melting snow and heavy rains. An unusually heavy snow cover had remained from January. On 1 February average depths on the ground ranged from 1 to 6 inches over the southern half of Ohio. Most of the snow had melted by 8 February and the resulting runoff combining with heavy rains during the last of February caused a considerable rise in river stages. By 1 March the Ohio River was at flood stage, and heavy rains during the first six days of March further aggravated the flood situation. Rainfall over the Hocking River Basin for the 10-day period, 25 February through 6 March, ranged from 5.75 inches at Athens to 6.61 inches at Lancaster and 6.62 inches at New Lexington. The maximum amount recorded for any one day was 3.31 inches at Lancaster on 6 March. At Enterprise, the Hocking River reached a stage of 20.1 feet, being only 1.9 feet below the 1907 flood and 0.4 feet below the 1913 flood. The crest stage at Athens during this flood was 23.0 feet, equivalent stage of 23.7 feet on the present gage, the second highest since the gage was established in 1915. The crest stage at Glouster was 17.7 feet, about 3.6 feet lower than that of the 1907 flood. Serious damage to urban and rural properties, railroads, and highways resulted from this flood, and damages were greater than normal due to intensified war-time activities in the area.

Storm and flood of April 1948. The Ohio Valley was covered by a continental-polar air mass on 11 April; but by that time the high center had moved off the Atlantic Coast and the air mass had undergone considerable modification. A new continental-polar air mass had entered the western United States and a cold front extended from Wisconsin to Oklahoma. Maritime air was entering the southern states along the Gulf of Mexico, and a warm front extended from Missouri to Mississippi and Georgia. The warm sector of this system crossed Ohio late on 11 April. Some rain accompanied the warm front, but, in general, the heaviest burst of the whole storm occurred during the night of 11-12 April when the cold front passed. The average rainfall for the period 11-14 April over the Hocking River Basin above Enterprise and Athens, was approximately 4.2 and 4.5 inches, respectively. The rainfall ranged from 4.13 inches at Lancaster to 5.25 inches at Athens. A crest stage of 17.52 feet was reached on the Enterprise gage on 13 April, 4.5 feet below the flood of 1907.

A crest stage of 21.86 feet was reached on the Athens U. S. Geological Survey gage on 13 April, 4.8 feet below the 1907 flood. Most of the damage was to fields that had just been seeded and required re-seeding.

Storm and flood of March 1963. Winter weather, which had come close to exceeding the coldest of record, turned unseasonably warm in the beginning of March. The ground was frozen to unusual depths. Thus, the stage was set for high runoff from any rainfall.

A large amplitude wave pattern over North America early in the month consisted of a ridge in the eastern Pacific and a trough extending from Hudson Bay into the Southern Plains. Heavy precipitation fell from the Central Plains eastward in association with the trough. Four or more inches of rain fell locally in some areas. A major storm system had developed in the far southwest the previous week and passed through the midwest on 4 March causing nearly all of the above precipitation. Much of the eastern half of the country continued to receive heavy precipitation during the week ending 17 March, with the heaviest amounts again concentrated in the Ohio and Tennessee Valleys and the central and southern Appalachians. This was associated with a series of storm systems which developed in the "Far West" and moved eastward to New England. Critical flooding developed in West Virginia, Virginia and Kentucky. The long-wave pattern continued to retrograde during the third week and it also amplified. There was less storminess during the period with most of the nation experiencing the passage of only one major low. This system moved eastward from the Great Basin on 17 March spreading moderate to heavy precipitation from the Central Plains over the Ohio Valley and much of the Appalachians. Totals for this storm were much less than during the previous two weeks. Rainfall amounts at Athens were 3.97 and 2.33 inches, respectively, for the two storm periods. The crest stage at the Athens gage on 6 March was 23.1 feet, the fourth highest of record.

Storm and flood of March 1964. The flood of March 1964 was the result of two storms. The first occurred on 4-5 March, when an average of 2.1 inches fell on the drainage area above Athens. This storm set the stage for excessive runoff from the second storm which occurred on 8-10 March and had a duration of approximately 24 hours. The average rainfall over the drainage area above Athens for the second storm was approximately 3.1 inches. This storm produced the second flood of record at Enterprise on the Hocking River, being exceeded only by the flood of March 1907. The May 1968 flood exceeded the March 1964 flood at Athens. The crest stage at Enterprise for the March 1964 flood was 21.31 feet and at Athens was 24.20 feet.

Storm and flood of May 1968. The flood of May 1968 was caused by heavy rains of 23-24 May falling on soil already saturated by previous rainfall. At the Athens rainfall station a total of 3.61 inches fell from 0700 hours, 23 May until 0700 hours, 24 May. At the Tom Jenkins Dam rainfall station a total of 3.80 inches fell during the same 24-hour period. The maximum flood storage at Tom Jenkins Reservoir was 8,370 acre-feet, equivalent to 4.76 inches of runoff.

The reservoir pool level reached elevation 731.52 feet, m.s.l., the maximum attained since operation began.

The flood of May 1968 produced a crest stage on the Hocking River at Enterprise gage of 18.2 feet on 24 May. Sunday Creek at Glouster gage crested at 17.8 feet on 24 May and Hocking River at Athens gage crested 24.6 feet on 25 May. This is the highest stage recorded at the Athens gage in the 54 years of record (1915-1968). Reductions effected by Tom Jenkins Reservoir were 0.6 feet at Glouster and 0.3 feet at Athens. High water marks indicate that the flood of May 1968 was as high or higher than the March 1964 flood at Athens and Nelsonville, but quite a bit lower at Logan and Enterprise.

Hocking River Basin - natural frequency of flooding. The probability of flooding on the Hocking River can best be judged from the records of past floods at the Enterprise and Athens gages. The records demonstrate that flooding is not restricted to any season, but that floods may occur in any month of the year. The frequency of flooding analysis for the two stations previously mentioned was developed using procedures outlined in "Statistical Methods in Hydrology" by Leo R. Beard, dated January 1962 and cited in EM 1110-1450 on Hydrologic Frequency Estimates, and published by the Chief of Engineers. The analysis was based on stream-flow records at Enterprise and Athens. The estimated natural frequencies of various stages and discharges for Hocking River at Enterprise and Athens are given in Table 15-13.

Ohio River - frequency of flooding. The flow reductions for Logan Reservoir were routed to the U. S. Geological Survey gage at Athens. These reductions were then furnished to the Ohio River Division Office in Cincinnati, Ohio, where damages prevented at appropriate Ohio River damage centers were computed.

Hocking River Basin - modified frequency of flooding. Table 15-14 lists the modified frequency stages at the Athens U. S. Geological Survey gage for pertinent combinations of considered projects.

Standard project storms and floods (general). The purpose and scope of this section is to present detailed data on the hypothetical storms and floods critical to the hydraulic design of flood control reservoirs considered in the Hocking River Basin. The Standard Project Storms and floods for small drainage basins are based on generalized rainfall criteria for drainage basins east of 105 degrees longitude as presented in EM 1110-2-1411. Analyses of the seasonal variation of generalized estimates of rainfall and of snow cover over the basin indicates that the summer-type storms are more severe than the winter-type. An outline of the drainage basin for the project was superimposed on the total storm isohyetal map of the Standard Project Storm so that the maximum flood runoff would result at the project under study. A review of the summer-type storms indicates that a minimum infiltration rate of 0.05 inch per hour may be experienced, and this value was adopted in determining rainfall excess. Studies of stream-flow

TABLE 15-13

NATURAL STAGE AND DISCHARGE FREQUENCIES

Average frequency, years	Enterprise: Stage feet 1/	Enterprise: Discharge, cubic feet per second 1/	Athens: Stage, feet 2/	Athens: Discharge, cubic feet per second 2/
100	23.9	37,000	28.4	48,000
50	21.9	28,500	26.5	38,500
20	20.3	21,000	24.4	29,200
10	19.2	16,800	23.2	24,200
5	17.6	12,800	21.9	19,800
2	15.1	8,700	20.1	14,800
1	13.2	6,400	18.7	11,800

1/ U.S.G.S. Gage; Zero = 723.6 feet above m.s.l.
2/ U.S.G.S. Gage; Zero = 614.81 feet above m.s.l.

TABLE 15-14

MODIFIED STAGE FREQUENCIES
AT ATHENS, OHIO 1/

Average frequency years	Natural stage feet	Modified by Tom Jenkins Res. (existing) and Logan Res. (Proposed)	Modified by proposed new channel conditions: With Tom Jenkins Res.	Modified by proposed new channel conditions: With Tom Jenkins Res. and Logan Res.
100	28.4	27.4	25.4	24.6
50	26.5	25.4	23.2	22.3
20	24.4	23.3	20.4	19.6
10	23.2	22.0	18.8	18.0
5	21.9	21.0	17.3	16.5
2	20.1	19.3	15.3	14.7
1	18.7	18.0	13.7	13.3

Note: Effects of Nine (9) Upper Hocking U. S. Department of Agriculture (USDA) Uncontrolled Structures (Drainage Area 26 ± Sq. Mi.) were considered to be negligible at Athens. A lack of information on proposed structures in the Rush and Margaret Creek Watersheds during the hydrologic analysis pertinent to this report precluded an evaluation of the flood control effects these structures would have throughout the Hocking River Basin.

1/ At Mill St. Gage - Zero = 614.81 Ft. m.s.l.

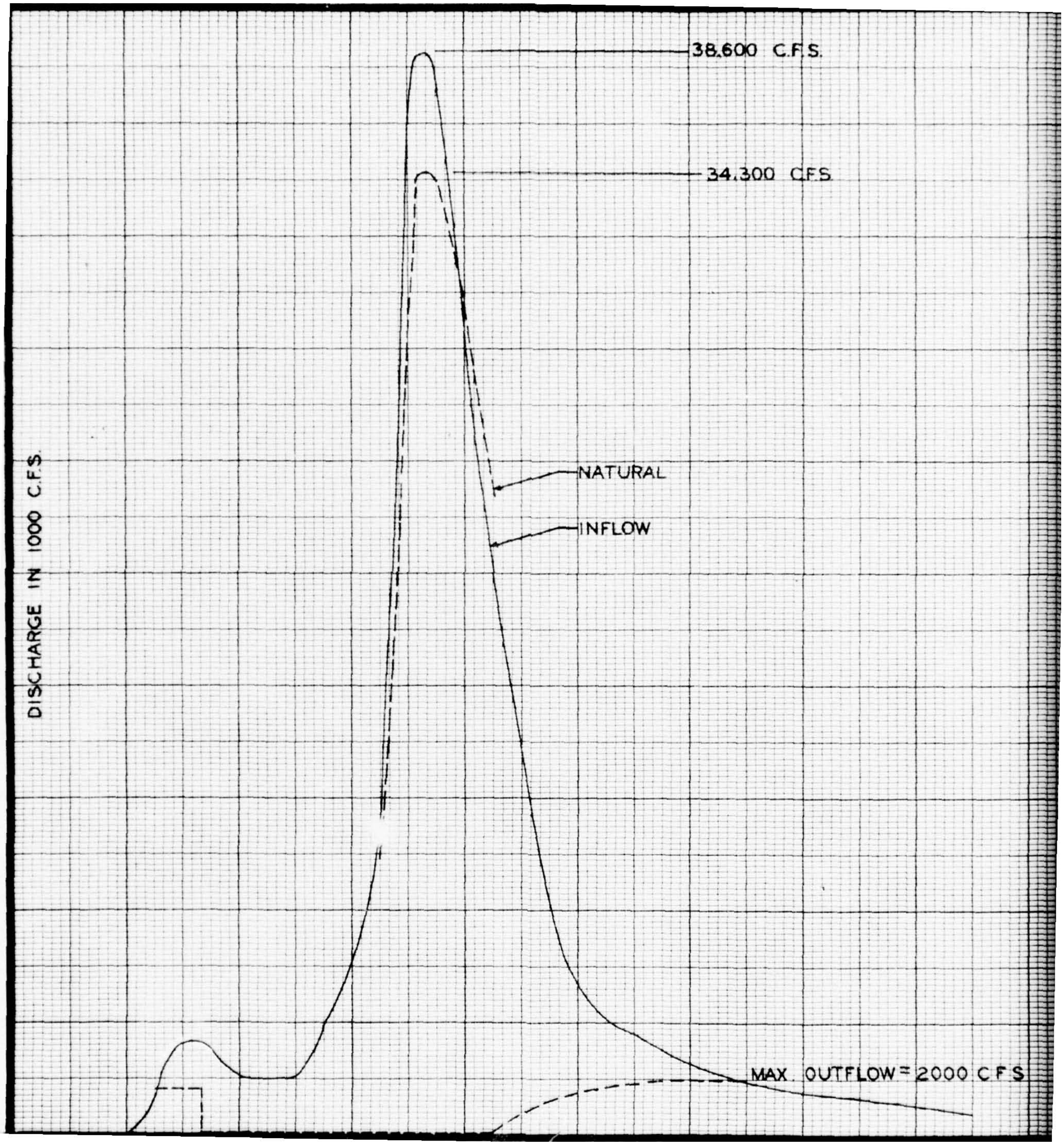
records in the Hocking River Basin indicate a base flow of approximately one c.f.s. per square mile and this value was adopted for the present study.

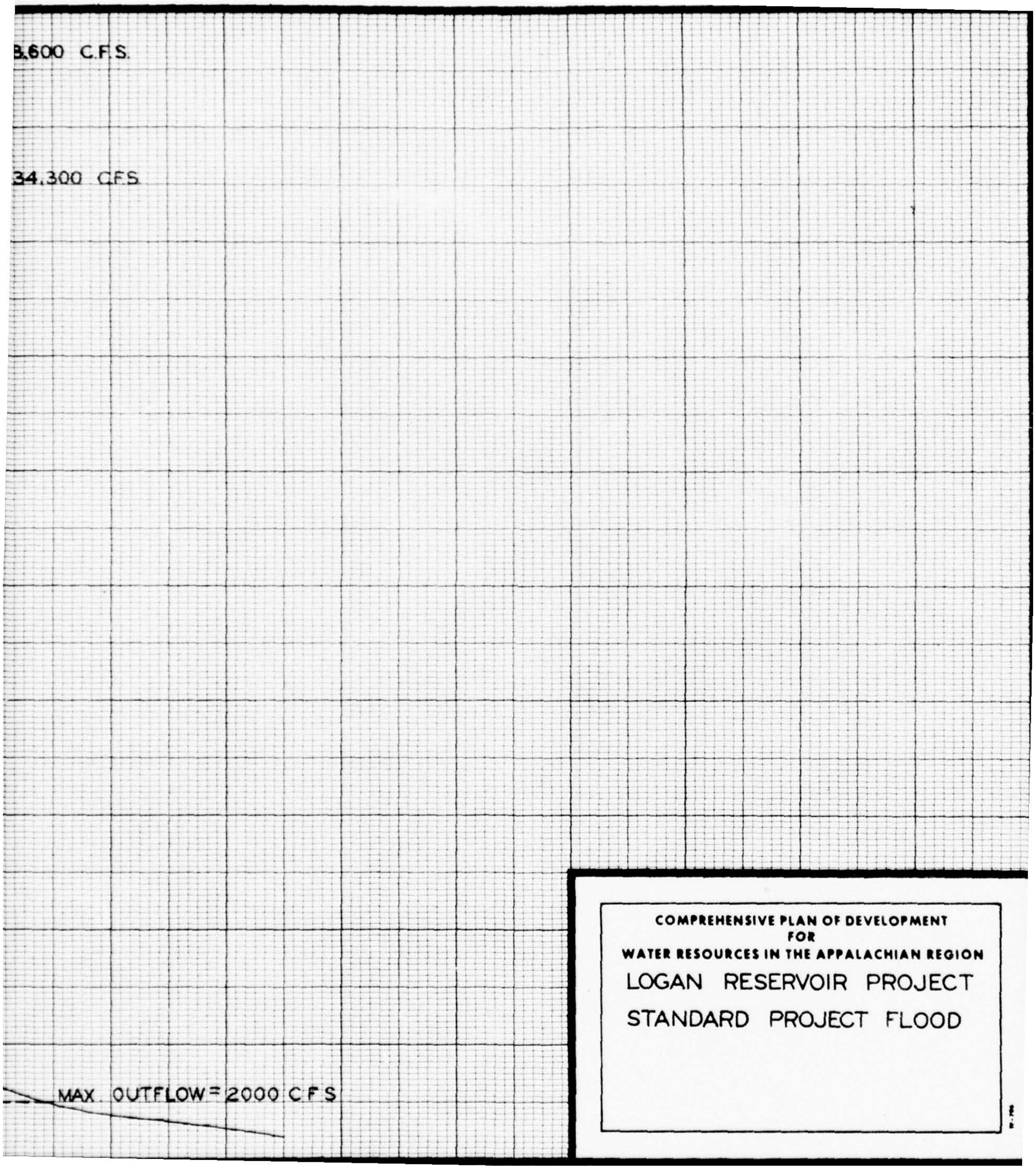
Standard project storm and flood for Logan Dam and Reservoir Project. The Logan Dam and Reservoir Project would have a spillway crest elevation of 868.3. Using the generalized rainfall estimates presented in EM 1110-2-1411, a Standard Project Storm and Flood was determined for the 84.1 square miles of drainage area above Logan Reservoir. Pertinent data for the spillway are presented in Table 15-15. The natural and outflow hydrographs are shown on exhibit 15-6.

Design storms and floods (general). A design storm and flood represents the limit of conditions against which flood protection can be provided within economic and physical limitations.

Investigations of flood control storage requirements of Logan Reservoir have been made with a view not only toward providing sufficient storage to effectively control recorded and historical floods on Clear Creek and Hocking River but also runoff from the most intense storms of record in adjacent watersheds that could have moved into and centered over Clear Creek Basin. The two largest floods that have occurred in and near the Hocking River Basin were the flood of August 1935, which centered near Newcomerstown, Ohio and the flood of March 1913 which centered at Bellefontaine, Ohio. To illustrate the desired flood control storage in Logan Reservoir Project, the largest of these storms, March 1913, was transposed to critically center over the drainage area above Logan Dam. If such a storm were to center above Clear Creek, it would require approximately 39,940 acre-feet of storage (8.9 inches of runoff from the drainage basin) to control the flood in accordance with the proposed regulation plan. Due to the improbability of exact centering of storms over a particular drainage area of 84.1 square miles, 8.0 inches of runoff was adopted as sufficient flood control storage in Logan Reservoir.

Design storm and flood for Logan Dam and Reservoir Project. Using the reservoir capacity which could be provided up to maximum flood control pool elevation, the Standard Project Flood for Logan Reservoir was reduced by a certain percentage to that flood which could be completely controlled by the reservoir. Since the Standard Project Flood is the result of summer-type storms, the reservoir design storm is of the summer-type. Pertinent data are given in Table 15-15.


38,600 C.F.S.
34,300 C.F.S.
NATURAL
INFLOW
DISCHARGE IN 1000 C.F.S.
MAX. OUTFLOW = 2000 C.F.S.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

LOGAN RESERVOIR PROJECT

STANDARD PROJECT FLOOD

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TABLE 15-15

STANDARD PROJECT STORM AND FLOOD - SUMMARY

Location	Drainage area, square miles	Stream	Rainfall, inches	Losses, inches	Runoff rainfall excess, inches	c.f.s.	Natural peak Discharge c.f.s. per square mile	Natural peak Discharge Regulated peak discharge c.f.s.	Reduction c.f.s.	Flood comparison Design flood, percent of S.P.F.
Reservoir Project										
Logan	84.1	Clear Creek	15.09	3.11	11.98	34,300	408	1,600	32,700	70.2

DESIGN STORMS AND FLOODS - SUMMARY

Location	Drainage area, square miles	Stream	Rainfall, inches	Losses, inches	Rainfall excess, inches	c.f.s.	Natural peak Discharge c.f.s. per square mile	Natural peak Discharge Regulated peak discharge c.f.s.	Reduction c.f.s.	Percent of S.P.F.
Reservoir Project										
Logan	84.1	Clear Creek	10.63	2.72	7.91	24,100	287	1,600	22,500	70.2

Spillway design storm and flood (general). The spillway design storm and flood estimates were prepared in accordance with EM 1110-2-1405. Hydrometeorological Report No. 33, prepared by the United States Weather Bureau, dated April 1956, presents estimates of the seasonal variation of the probable maximum precipitation east of the 105th meridian for areas up to 1,000 square miles and durations up to 48 hours. Spillway design flood inflow hydrographs were constructed which represent the critical volume and concentration of runoff into the reservoir under the most extreme conditions considered reasonably possible.

Probable maximum precipitation. The month of August was selected as the most critical storm producing period. Rainfall values obtained from HMS Report No. 33 were reduced by a basin shape factor of 13 percent in accordance with criteria presented in Engineer Circular No. 1110-2-27, dated 1 August 1966. The 24-hour rainfall values were arranged in the most critical order and the 6-hour values in each 24-hour period were further arranged in the most critical order. The probable maximum precipitation represents the critical depth-duration-area rainfall relations that would result if conditions during an actual storm in the region were increased to represent the most critical conditions that are considered probable of occurrence. The reduced 48-hour average rainfall over the watershed above Logan Dam is listed in Table 15-16.

TABLE 15-16

PROBABLE MAXIMUM PRECIPITATION

Reservoir	Logan
Drainage area, square miles	84.1
Stream	Clear Creek
Average depth of precipitation, inches	24.80

Unit hydrograph development for spillway design flood. The formation of a long reservoir in a natural drainage basin may materially alter the regimen of flood runoff by synchronizing high rates of runoff originating above the head of the reservoir with maximum rates from areas contributing laterally to the reservoir. The time required for flood waves to traverse natural channels within the limits of the proposed reservoir is several hours. The time required for inflow into the upper end of the full reservoir to become effective at the point of reservoir outflow ranges from practically zero to about one hour. For the purpose of this report, zero time of travel is assumed in all cases. The critical rate of inflow into a full reservoir during the spillway design storm was estimated by dividing the drainage area contributing to the full reservoir into three or more sub-areas; namely (1) principal tributaries, (2) minor sub-areas immediately adjacent to the

reservoir, and (3) the reservoir surface. Unit hydrographs were derived for the respective sub-areas by use of such hydrologic data as were available and supplemented by synthetic unit hydrograph computations. The rate of runoff from the reservoir surface was taken equal to the rate of rainfall. Exhibit 15-7 shows the unit hydrographs used in developing the spillway design flood for the Logan Reservoir project. An error in the tabulation of the unit hydrograph ordinates for Area 2 will not significantly affect the spillway design flood and these corrections will be made in future detailed project studies.

Hypothetical hydrographs of Runoff from spillway design storm. Hydrographs of runoff from the various sub-areas above the proposed reservoir, corresponding to the spillway design storm rainfall-excess quantities, were computed and combined in proper time relation to obtain a composite hydrograph of reservoir inflow. Hydrographs were obtained as follows: (1) a provisional spillway design flood hydrograph representing runoff from the area above the dam site under natural river conditions, (2) a provisional spillway design flood inflow hydrograph representing runoff into a full reservoir, reflecting the effect of the reservoir in modifying the regimen of runoff, and (3) a group of hypothetical hydrographs representing greater concentrations of runoff but having the same volume as the provisional spillway design flood inflow hydrograph. Exhibit 15-8 shows the various hypothetical hydrographs of runoff from the spillway design storm and the spillway design flood inflow hydrograph proposed for adoption of Logan Reservoir.

Adopted spillway capacity. The spillway capacity is based on a spillway design flood inflow hydrograph which assures a safe estimate of the maximum reservoir level which would result from the adopted size and type of spillway and the proposed method of operation. Pertinent data on the spillway capacity for Logan Reservoir are listed in Table 15-17.

TABLE 15-17
SPILLWAY CAPACITY DATA 1/

	Logan Reservoir
Drainage area, square miles	84.1
Stream	Clear Creek
Maximum reservoir inflow, c.f.s.	83,600
Maximum spillway discharge, c.f.s.	18,400

1/ Derived from Probable Maximum Precipitation Estimates and application of derived inflow unit hydrographs. Values given are predicated on the assumption that the reservoirs are filled to 100% of maximum flood control storage at the onset of the Spillway Design Flood.

Unit hydrographs. Unit hydrographs were derived, where possible, by analysis of records of runoff resulting from an isolated unit storm which produced reasonably uniform rainfall-excess rates. Exhibit 15-9 shows the storm analyzed and exhibit 15-10 shows the unit hydrograph pertinent data for Clear Creek near Rockbridge, Ohio.

Exhibit 15-11 is a tabulation of the unit hydrograph ordinates for Clear Creek near Rockbridge. Synthetic unit hydrographs were constructed as required and served as a substitute for hydrographs derived from actual records and as a means of correlating and supplementing observed data.

Reservoir regulation. Any reservoir or group of reservoirs in the Hocking River Basin must be considered as part of an integrated flood control system for the entire Ohio River Basin, and the method of regulation must therefore be correlated with the operation of reservoirs on other tributaries of the Ohio River. For the purpose of this report, a plan of reservoir operation was established, consistent with the foregoing statement, which provides a reliable index of the benefits resulting from operation of the one existing reservoir and the proposed reservoir. Full consideration was given to local requirements. The plan of operation is predicated on the assumption that an adequate flood forecasting and flood warning system would be in operation at all times. Control stages on the Hocking River during the winter season have been established somewhat higher than during the summer season, but only minor damage would result to the agricultural lands during the winter months. It is considered desirable to empty the reservoirs as quickly as possible during the winter months in view of the possibility of a major flood occurring at a time when the reservoirs might be partly filled. Operation for Ohio River control will begin in advance of a predicted crest stage of 40 feet at Belleville Locks and Dam, lower gage, and storage will continue until the Ohio River has crested and fallen, and further recession is indicated. A stage of 40 feet at Belleville Locks and Dam, lower gage, represents the point at which damage begins in unprotected communities of the Ohio Valley below Belleville Locks and Dam. Table 15-18 lists control flows and stages at key stations on the Hocking River and its tributaries.

Plan of reservoir regulation.

a. Flood control. During periods of storm runoff, Logan and Tom Jenkins Reservoirs would be operated to utilize the natural channel capacities by releasing storage at rates not to exceed the designated control stages as given in Table 15-18. For Hocking River and Sunday Creek control, storage of flood flows would begin in advance of predicted damaging stages at key points and continue until predicted stages for all control points indicate that release of stored waters would not cause stages in excess of downstream control stages. For Ohio River floods, closure of Tom Jenkins and Logan Reservoirs would be based on a crest stage forecast in excess of 40 feet at Belleville Locks and Dam,

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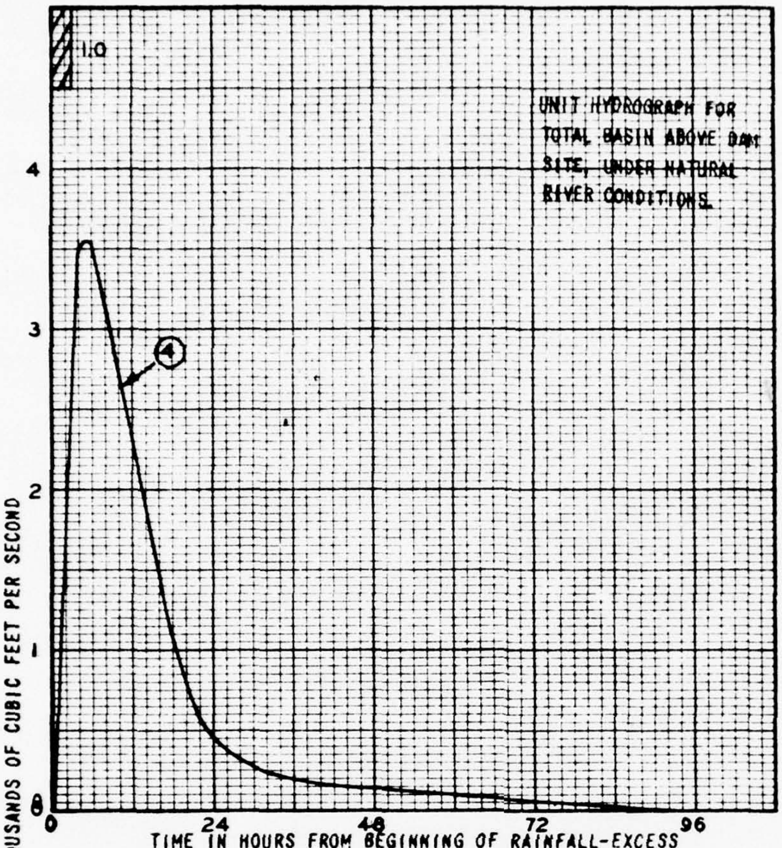
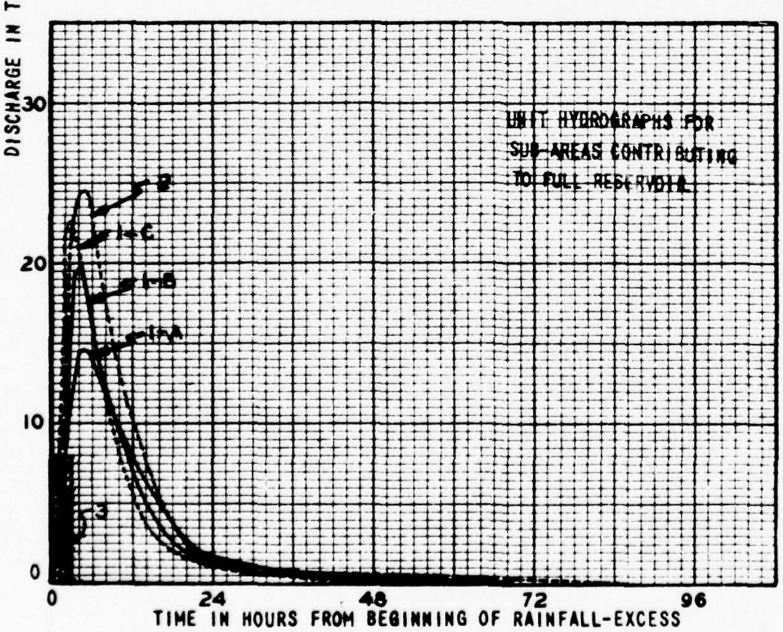




UNIT HYDROGRAPH TABULATION

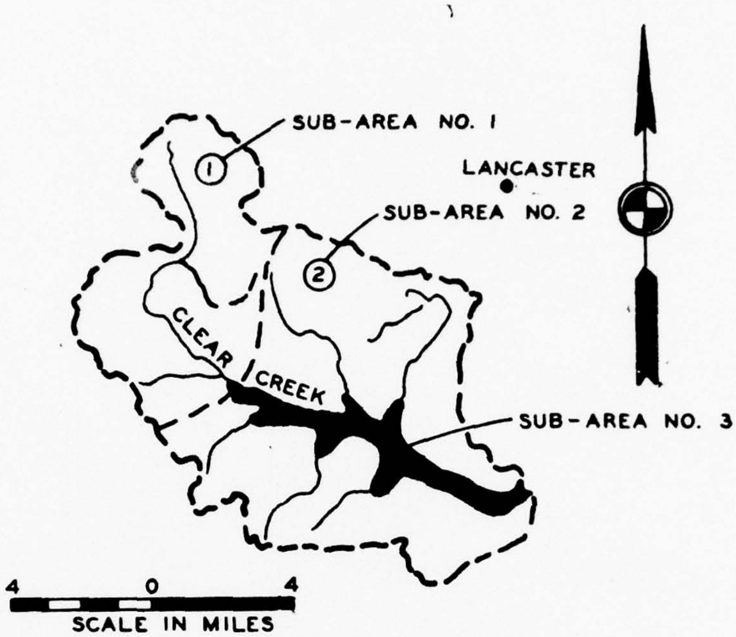
TIME IN HOURS	INSTANTANEOUS DISCHARGE IN cfs AT TIME DESIGNATED				
	1-A	1-B	1-C	2	4
0	0	0	0	0	0
3	1100	1660	2260	2130	2650
6	1430	1800	1630	2376	3540
9	1090	1090	1000	1589	2975
12	810	710	570	1051	2300
15	570	430	340	677	1670
18	380	260	210	374	1100
21	240	190	150	202	675
24	175	140	110	149	470
27	140	100	80	115	350
30	110	85	70	110	275
33	90	70	60	96	230
36	75	60	40	86	200
39	65	50	30	82	175
42	55	40	20	77	160
45	50	30	5	72	150
48	40	20	0	67	135
51	35	10		65	130
54	30	0		60	125
57	25			57	120
60	18			52	100
63	10			48	90
66	5			43	80
69	0			39	70
72				31	60
75				26	40
78				17	30
81				9	25
84				4	20
87				0	10
90					5
95					0

DEPARTMENT OF THE ARMY

HYDROGRAPH TABULATION

INSTANTANEOUS DISCHARGE IN cfs AT TIME DESIGNATED

1-B	1-C	2	4
0	0	0	0
1860	2260	2130	2650
1800	1630	2376	3540
1090	1000	1589	2975
710	570	1051	2300
430	310	677	1670
260	210	374	1100
190	150	202	675
140	110	149	470
100	80	115	350
85	70	110	275
70	60	96	230
60	40	86	200
50	30	82	175
40	20	77	160
30	5	72	150
20	0	67	135
10		65	130
0		60	125
		57	120
		52	100
		48	90
		43	80
		39	70
		31	60
		26	40
		17	30
		9	25
		4	20
		0	10
			5
			0



LOCATION MAP

DATA RELATING TO UNIT HYDROGRAPH				
NO.	UNIT DURATION IN HOURS	AREA REPRESENTED IDENTIFICATION	SQ. MI.	REMARKS
1-A	3	Sub-Area No. 1	31.2	Area at head of reservoir.
1-B	3	" " "	"	Alternate to 1-A; Peak 125% of 1-A.
1-C	3	" " "	"	" " " 150% " ".
2	3	" " No. 2	49.1	Estimated for sum of small areas.
3	3	" " No. 3	3.8	Rate of runoff = Rainfall intensity.
4	3	Total at dam	84.1	For natural river conditions.

HOCKING RIVER
OHIO

LOGAN RESERVOIR PROJECT

UNIT HYDROGRAPHS USED IN DEVELOPING SPILLWAY DESIGN FLOOD CRITERIA

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HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. APRIL 1967

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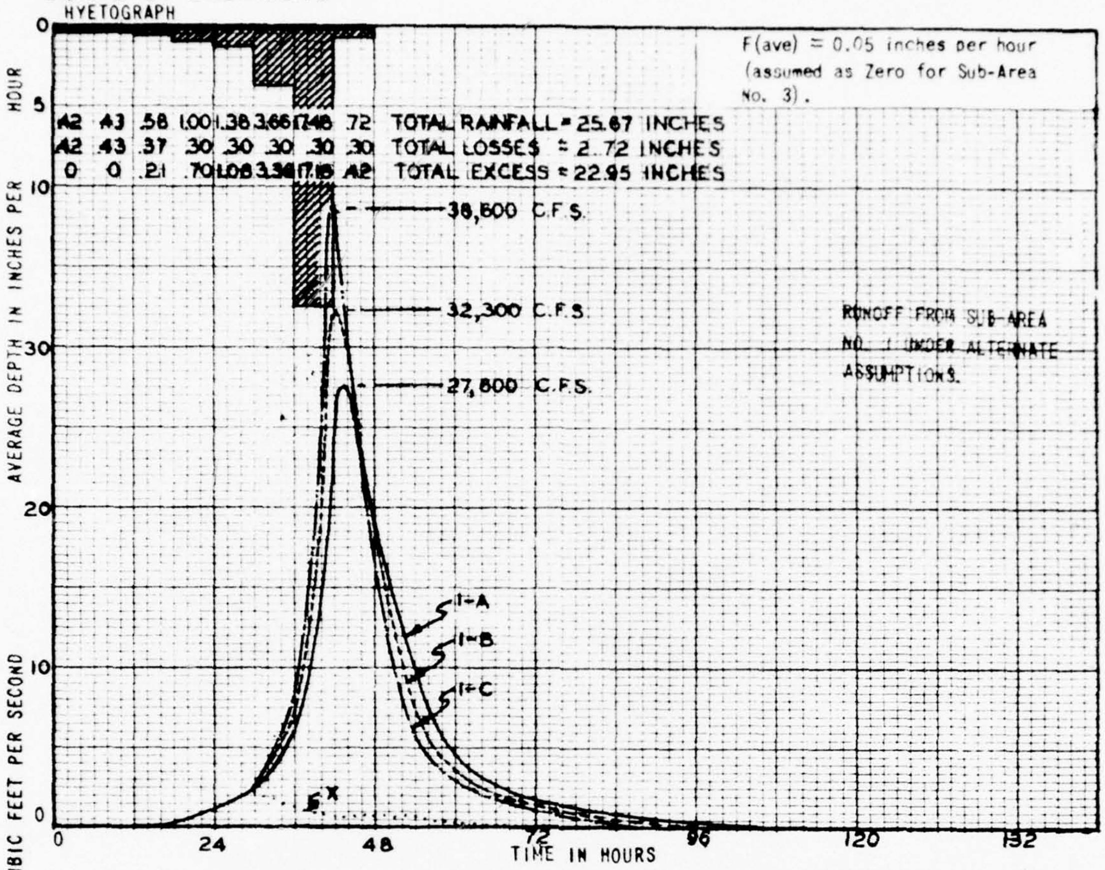

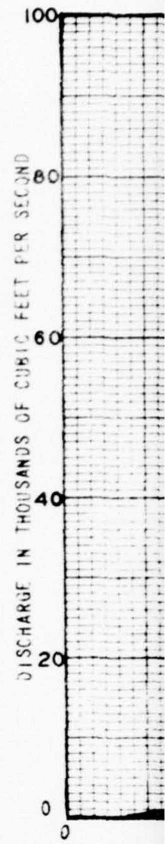

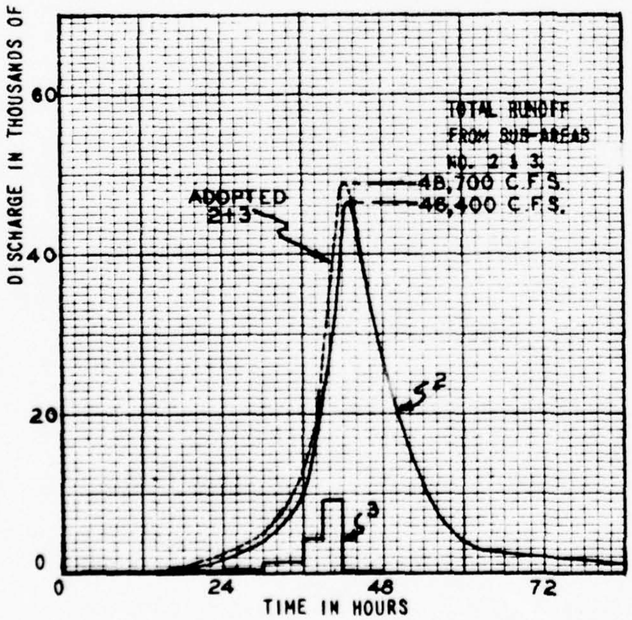

DATA RELATED TO HYPOTHETICAL HYD

HYDRO-GRAPH NO.	AREA REPRESENTED		UNIT GRAPH	RE
	SUB-AREA	SQ. MI.		
X	No. 1	31.2	1-A	Runoff from design storm, exclusi
*1-A	"	"	"	Hydrograph "X" + runoff from 2 M
1-B	"	"	1-A; 1-B	" "
1-C	"	"	1-A; 1-C	" "
*2	No. 2	49.1	2	Summation of small areas adjacent
*3	No. 3	3.8	3	Reservoir surface.
*A	Total	84.1	-	Hydrograph No. 1-A + No. 2 + No. reservoir.
**B	"	"	-	Hydrograph No. 1-B + No. 2 + No. reservoir.
C	"	"	-	Hydrograph No. 1-C + No. 2 + No. reservoir.
*D	"	"	-	Represents flow at dam site unde

**Selected as "Spillway Design Flood."
*Represents "Provisional Spillway Design Flood" runoff under condi

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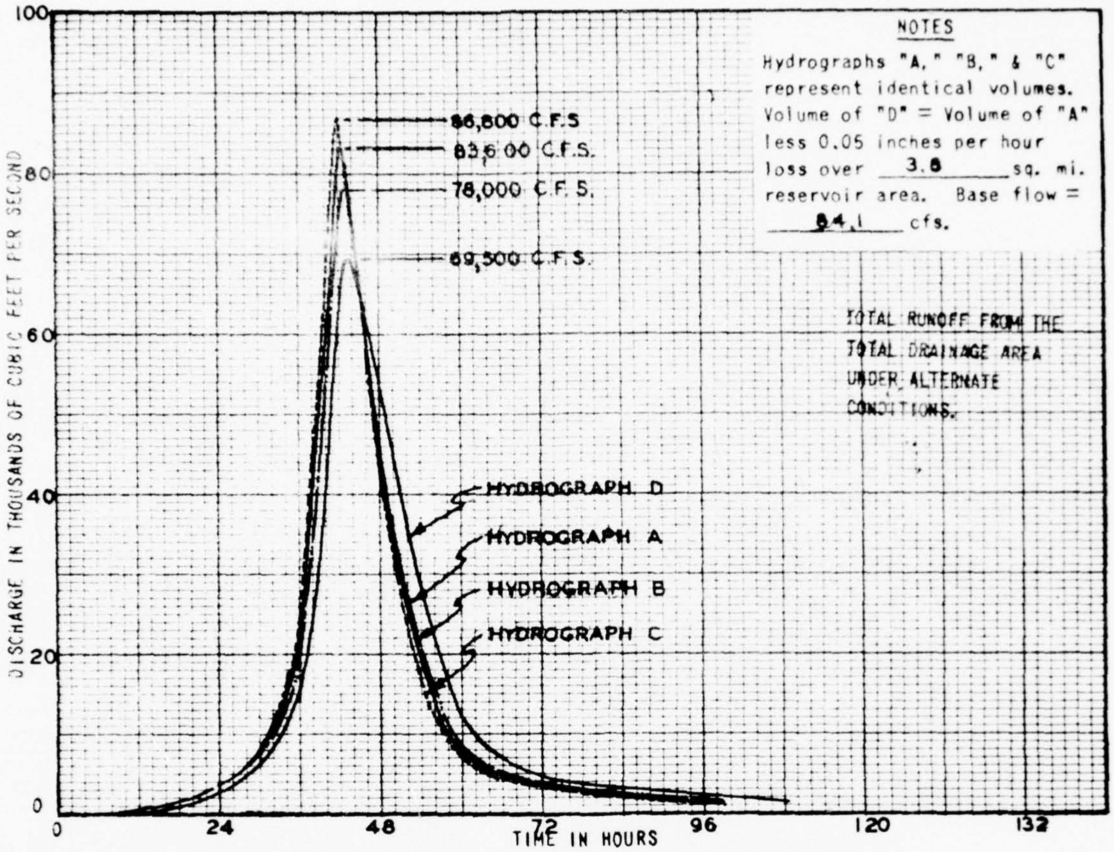

NOTES

Hydrographs "A," "B," & "C" represent identical volumes. Volume of "D" = Volume of "A" less 0.05 inches per hour loss over 3.8 sq. mi. reservoir area. Base flow = 84.1 cfs.

ATA RELATED TO HYPOTHETICAL HYDROGRAPHS

REMARKS
noff from design storm, exclusive of 2 Max 6 Hr. R_e (2054).
ydrograph "X" + runoff from 2 Max 6 Hr. R_e computed by U.G. I-A.
" " " " I-B.
" " " " I-C.
mmation of small areas adjacent to reservoir.
servoir surface.
ydrograph No. I-A + No. 2 + No. 3 represents inflow into full eservoir.
ydrograph No. I-B + No. 2 + No. 3 represents inflow into full eservoir.
ydrograph No. I-C + No. 2 + No. 3 represents inflow into full eservoir.
epresents flow at dam site under natural conditions.

od."

y Design Flood" runoff under conditions and from areas designated.

NOTES

Rainfall amounts based on Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian." & REDUCED BY BASIN SHAPE FACTOR IN ACCORDANCE WITH EC NO. 1110-2-27. Unit Hydrographs applied and listed in the Data Chart are shown on Exhibit No. ________.

HOCKING RIVER
OHIO

LOGAN RESERVOIR PROJECT

HYPOTHETICAL HYDROGRAPHS
OF RUNOFF FROM SPILLWAY
DESIGN STORM

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HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.VA. APRIL 1967

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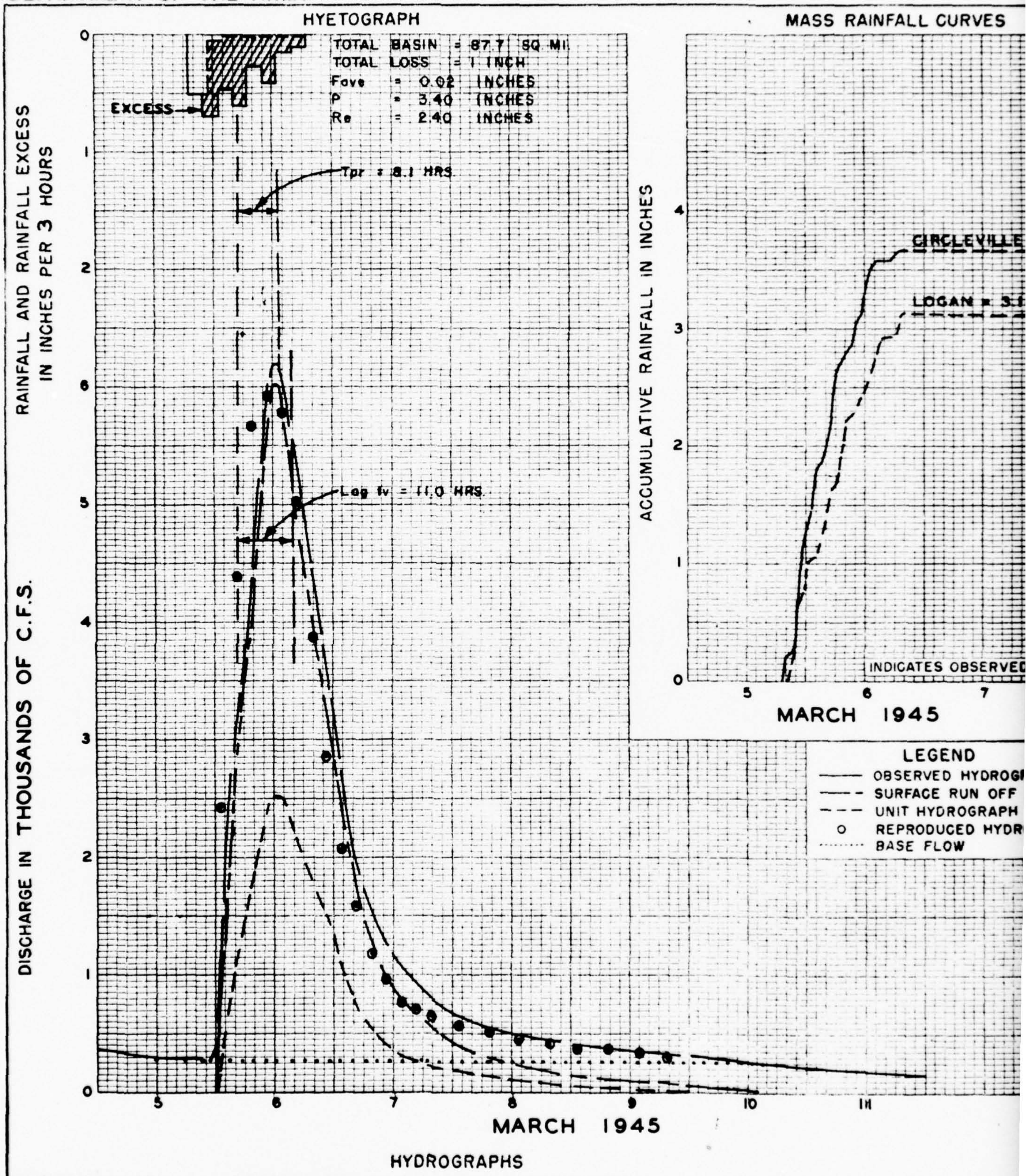

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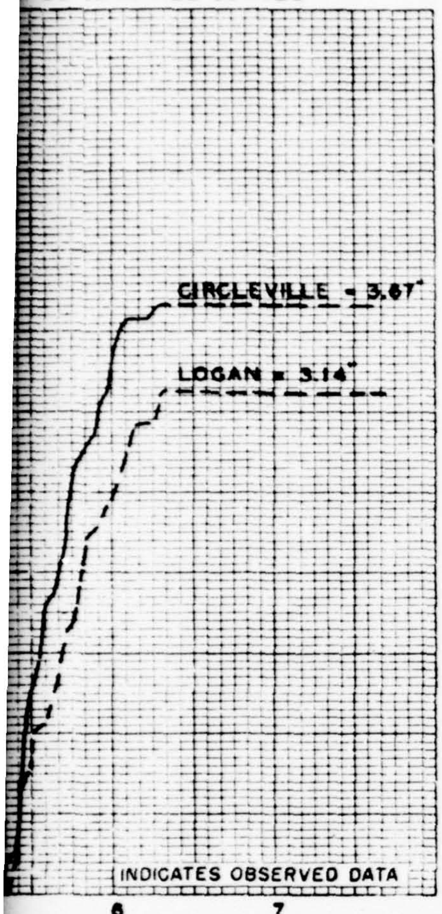
SUPERSEDES ENG. FORM 1822 1 NOV. 49, WHICH MAY BE USED UNTIL STOCK IS EXHAUSTED

ASS RAINFALL CURVES



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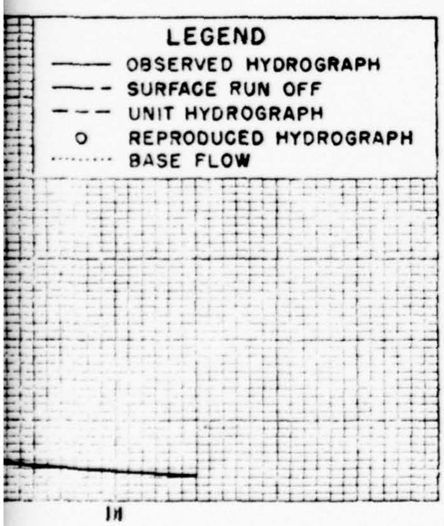
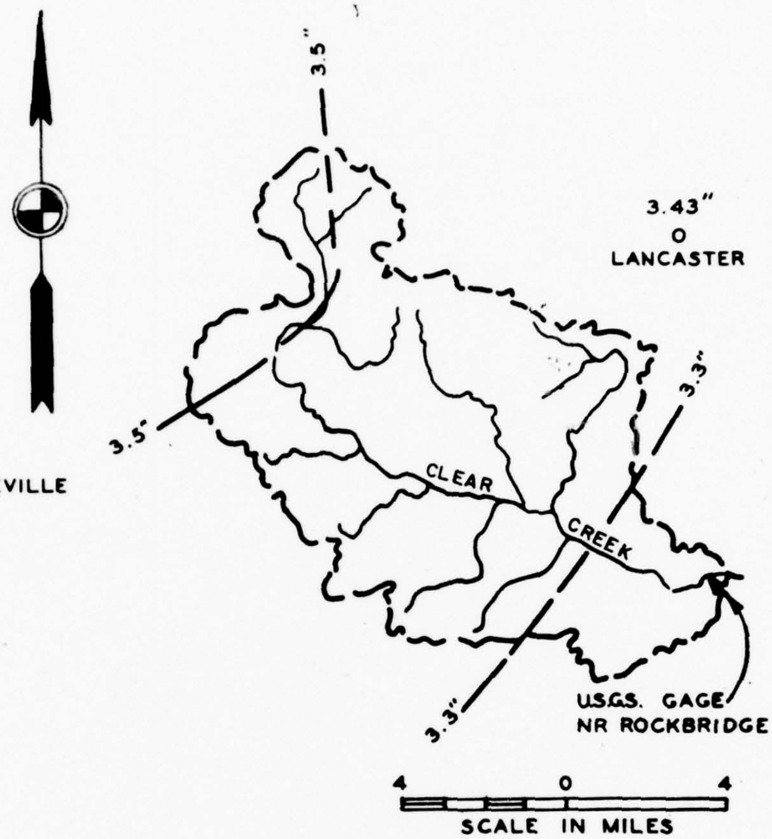


BASIN MAP



LEGEND

	REC.	NON REC.
PRECIPITATION GAGES	●	○
STREAM GAGES	▲	△
ISOHYETS	———	———
THIESSEN POLYGON	- - - - - - - -	
ZONE BOUNDARY		

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

CLEAR CREEK
NEAR ROCKBRIDGE, OHIO

BASIC DATA
(Sheet 1 of 2)

JANUARY 1965

SUBMITTED BY
DISTRICT ENGINEER, DISTRICT

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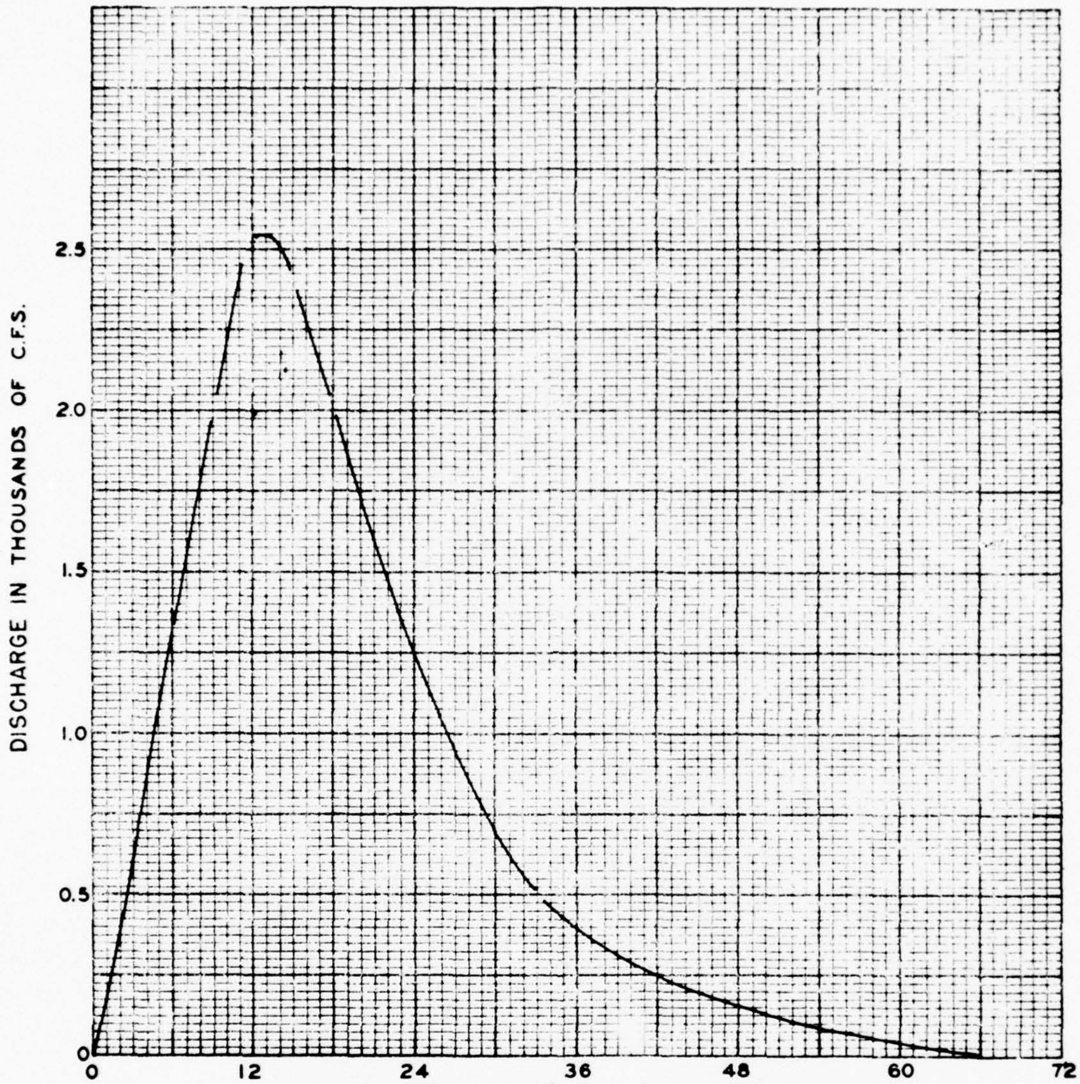
OBSERVED UNIT HYDROGRAPHS



DRAINAGE AREA
MAXIMUM ELEVATI
MINIMUM ELEVATI
MEAN ELEVATION
LAND SLOPE
MAIN STREAM SL

DATA FROM OBSERVED UNIT HYDROGRAPHS

DATE OF RAINFALL	LEGEND	AVE. P (in.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (In.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (cfs.)	Q_p tr = 3 hrs. (cfs.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
5-6 MAR. 1945	———	3.40	21.0	2.40	UNIF.	REC.	2530	3700	8.0	8.1	11.0	1.65

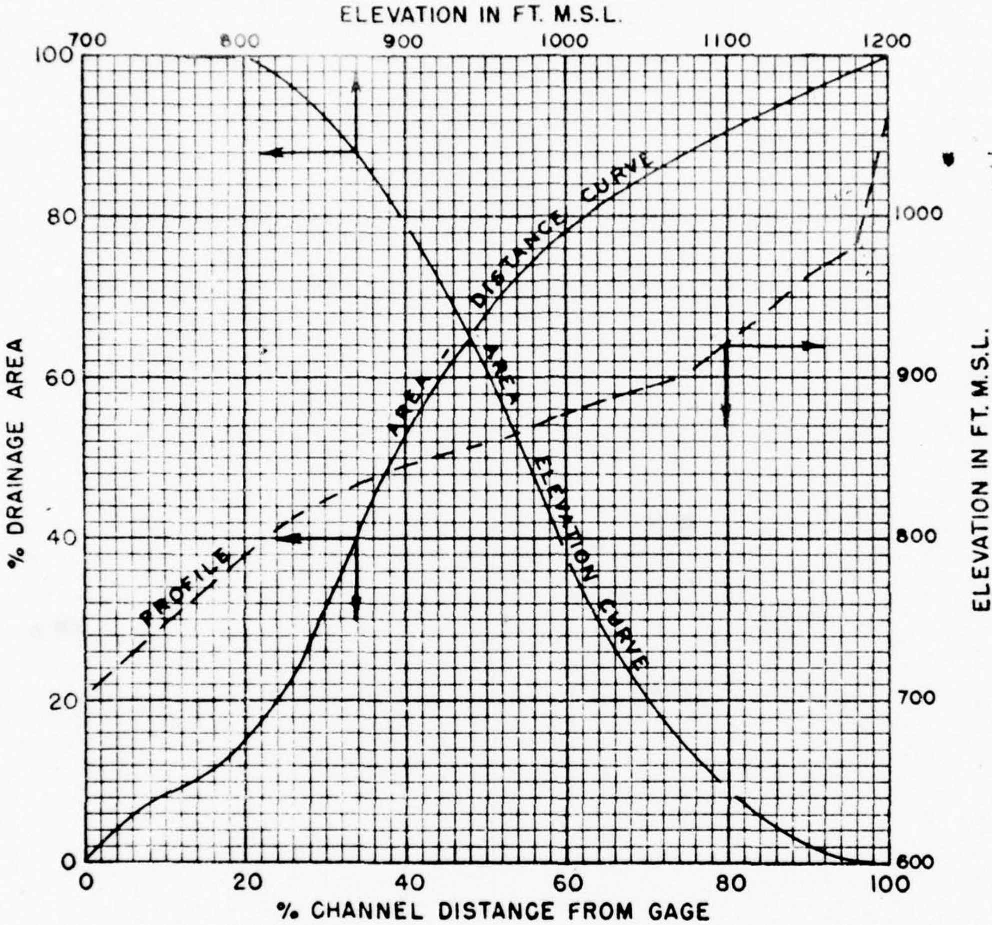
ENG FORM 1821
1 OCT. 50

SUPERSEDES ENG. FORM 1821, 1 NOV. 49,
WHICH MAY BE USED UNTIL STOCK IS EXHAUSTED

CORPS OF ENGINEERS

DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	87.7	sq. mi.	L	21.3	mi.
MAXIMUM ELEVATION	1100	ft. m.s.l.	L_{ca}	9.3	mi.
MINIMUM ELEVATION	755	ft. m.s.l.	$(LL_{ca})^{0.3}$	4.89	
MEAN ELEVATION (weighted)	925	ft. m.s.l.	DRAINAGE DENSITY	1.72	mi/sq. mi.
LAND SLOPE	512	ft./mi.	MAP SCALE	1:62,500	
MAIN STREAM SLOPE	5.96	ft./mi.	METHOD OF FLOW SEPARATION	A	
			BASIN SHAPE FACTOR	5.2	



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OGRAPHS							
Q_p tr = 3 hrs. (cfs.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_p640	K_m (hr.)	T_c (hr.)
(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
3700	8.0	8.1	11.0	1.65	234	11.2	5.0

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS

CLEAR CREEK
NEAR
ROCKBRIDGE, OHIO

JANUARY 1965

SUBMITTED BY
DISTRICT ENGINEER, DISTRICT.

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DEPARTMENT OF THE ARMY | UNIT HYDROGRAPH BASIC DATA SHEET | CORPS OF ENGINEERS (SHEET 2 OF 2)

(7) STREAM AND STATION CLEAR CREEK AT ROCKBRIDGE LAT. 39°35'20" LONG. 82°34'40"

(8) DATE OF STORM 5-6 March 1945 (9) OFFICE HUNTINGTON DISTRICT

(10) DRAINAGE AREA 87.7 SQ.MI. (11) L 21.3 MI. (12) L_{ca} 9.3 MI. (13) $(LL_{ca})^{0.3}$ 4.89

(14) AVERAGE RAINFALL 3.40 IN. (15) t_R 21.0 HRS. (16) DIRECT RUNOFF 2.40 IN.

(17) Q_{pR} 2530 CFS. (18) q_{pR} 28.9 CFS/SQ.MI. (19) Q_p 3700 CFS. (20) t_{pR} 8.0 HRS.

(21) t_p 8.1 HRS. (22) t_v 11.0 HRS. (23) C_{tR} 1.65 (24) $C_p 640$ 234 W_{50} 12.0 HRS. W_{75} 7.5 HRS.

TIME (25)	OBSERVED DISCHARGE (1000 CFS) (26)	ESTIMATED BASE FLOW (1000 CFS) (27)	DIRECT RUNOFF (1000 CFS) (28)	OBSERVED 21 HR UNIT HYDROGRAPH (1000 CFS) (29)	ADJUSTED 3 HR UNIT HYDROGRAPH (1000 CFS) (30)	REPRODUCED STORM HYDROGRAPH (1000 CFS) (31)	(32)	(33)
5-11P	250	250	0	0	0	250		
6-2A	1500	250	1250	550	2600	2434		
5A	3350	250	3100	1365	3700	4372		
8A	4600	250	4350	1920	3100	5675		
11A	5600	250	5350	2360	2450	5920		
2P	6070	250	5820	2560	1800	5770		
5P	5400	250	5120	2260	1250	5037		
8P	4500	250	4250	1870	820	3864		
11P	3550	250	3300	1450	550	2853		
7-2A	2650	250	2400	1060	400	2080		
5A	1970	250	1720	760	320	1542		
8A	1500	250	1250	550	250	1180		
11A	1230	250	980	430	220	962		
2P	1060	250	810	355	180	814		
5P	930	250	680	300	160	731		
8P	820	250	570	250	150	661		
11P	720	250	470	210	140	615		
8-2A	640	250	390	170	125	574		
5A	580	250	330	145	110	542		
8A	550	250	300	130	100	515		
11A	510	250	260	115	90	488		
2P	480	250	230	100	75	465		
5P	450	250	200	90	60	443		
8P	400	250	150	65	50	418		
11P	380	250	130	55	45	397		
9-2A	370	250	120	50	40	376		
5A	350	250	100	45	30	351		
8A	330	250	80	35	25	333		
11A	300	250	50	20	20	311		
2P	280	250	30	15	15	292		
5P	270	250	20	10	10	280		
8P	260	250	10	5	5	267		
11P	250	250	0	0	0	260		

DATE COMPUTED BY

lower gage. The reservoirs would remain closed until the Ohio River at Belleville Locks and Dam had crested, fallen one foot and further recession was indicated as determined by the U. S. Weather Bureau. Ohio River and tributary operation times for Logan Reservoir are as follows:

Logan Dam to Enterprise	3 hours
Logan Dam to Athens	24 hours
Logan Dam to Belleville Locks and Dam (Ohio River)	72 hours

At the end of the regulation period, outflows from Logan Reservoir would be gradually increased to channel capacity of 1600 c.f.s. and maintained at that rate until flood storage is released or until downstream flood conditions require further reservoir operation.

TABLE 15-18

CONTROL FLOWS AND STAGES AT KEY STATIONS

Station	Drainage area, square miles	Summer Stage, feet	Summer Flow, c.f.s.	Winter Stage, feet	Winter Flow, c.f.s.
Hocking River at Enterprise	460	11.0	4,430	12.0	5,190
Sunday Creek at Burr Oak 1/	56.8	687.0 2/	620	688.0 2/	840
Sunday Creek at Glouster	104	12.5	1,440	14.0	1,980
Hocking River at Athens	944	16.0	8,910	16.0	8,910

1/ Tom Jenkins Reservoir "A" gage
2/ Elevation in feet above m.s.l.

Water supply and water quality control. Allocation of total storage in the Logan Reservoir for multipurpose benefits was based on demands estimated by FWPCA. Water supply storage would be adequate to insure a maximum of 24 million gallons per day for direct withdrawal from the reservoir and piping to Lancaster. Storage for minimum releases would be adequate to maintain a minimum flow of 15 c.f.s. in Clear Creek. Water quality control storage is included to provide additional releases that will be required during the months of August and September after year 2020.

Sufficient storage to satisfy minimum releases, water supply and water quality control demands were determined from a hydrologic analysis of 25 years of record for the gaging station on Clear Creek near Rockbridge, Ohio. An electronic computer was utilized to simulate various plans of reservoir operation to satisfy each water use demand individually and in different combinations with each other. Based on the results of this study, 37,100 acre-feet of total storage would be necessary to provide required minimum releases, water supply and water quality control demands for the year 2070. Storage values and priority of allocation of storages for each water demand are as follows:

Minimum release -	3,725 acre-feet
Water supply -	29,900 acre-feet
Water quality control -	3,475 acre-feet
Total, combined purposes -	37,100 acre-feet

The adopted annual plan of operation for the combined purposes is presented as exhibit 15-12. This schedule should be considered as preliminary and only be used as a guide in the design stage of development. Later refinements of rules of operation are usually necessary, based on further detailed studies and on actual operating experience gained at similar existing projects.

Effects of reservoir regulation.

Flood control. The present plan of flood control regulation for Tom Jenkins and Logan Reservoirs was tested by application to (1) major floods of record in the Hocking River Basin and on the Ohio River, (2) the standard project flood for Athens Local Protection Project and (3) the standard project flood for each reservoir. Reservoir reductions were determined and routed to selected downstream damage centers to obtain modified hydrographs which indicate the effect of reservoir regulation on natural hydrographs. Results of reservoir regulation on the Athens standard project flood are shown on exhibit 15-13. Additional Ohio River benefits, attributed to Logan Reservoir, were determined by the Ohio River Division office in Cincinnati, Ohio. This was accomplished by applying routed Logan Reservoir reductions to Ohio River hydrographs modified by existing reservoirs, those under construction and those expected to be completed prior to 1970.

Water supply and water quality control. Reservoir releases made in accordance with annual plan of operation, tested over 25 years of record from 1940 - 1965, would provide all needs for minimum releases, water supply and water quality control. Based on this period of record, water supply demands would be maintained 100 percent of the time. The average annual demands at Lancaster are projected to

increase from about five m.g.d., currently, to 12 m.g.d. in 2020 and 20 m.g.d. in 2070. The average summer month demand by 2070 is estimated at 24 m.g.d., which is equal to the maximum assured supply from the reservoir. Also, based on the period of record, the 15 c.f.s. minimum flow would be maintained 100 percent of the time. The additional releases needed after year 2020 to maintain up to 29 c.f.s. total flow in Clear Creek during August and September will be met nine out of 10 years. For drought conditions occurring 1 out of 10 years, some amount less than the desired water quality control demand would be provided in accordance with the regulation schedule.

Recreation. Withdrawals and releases for water supply and water quality control would result in drawdown of the normal pool, thereby affecting recreation development and usage. Drawdown-frequency curves were computed for each month during the recreation season under conditions projected for the years 2020 and 2070. This study, based on a period of record from 1940 through 1966, indicates that during the recreation season in the first half of the project life, a drawdown of slightly over three feet can be expected to occur less frequently than one time every ten years. Since the water supply demands on the project will increase later in the project life, so will the maximum expected drawdown. Very late in the project life a drawdown of about five feet can be expected once every five years during the recreation season. A three-foot drawdown will reduce the surface area to about 1,575 acres and a five-foot drawdown to about 1,463 acres.

Table 15-19 gives frequency of drawdown values expected to occur for Logan Reservoir during the months of June, July and August for the years of 2020 and 2070.

TABLE 15-19
LOGAN RESERVOIR
FREQUENCY OF DRAWDOWN AT END OF MONTH

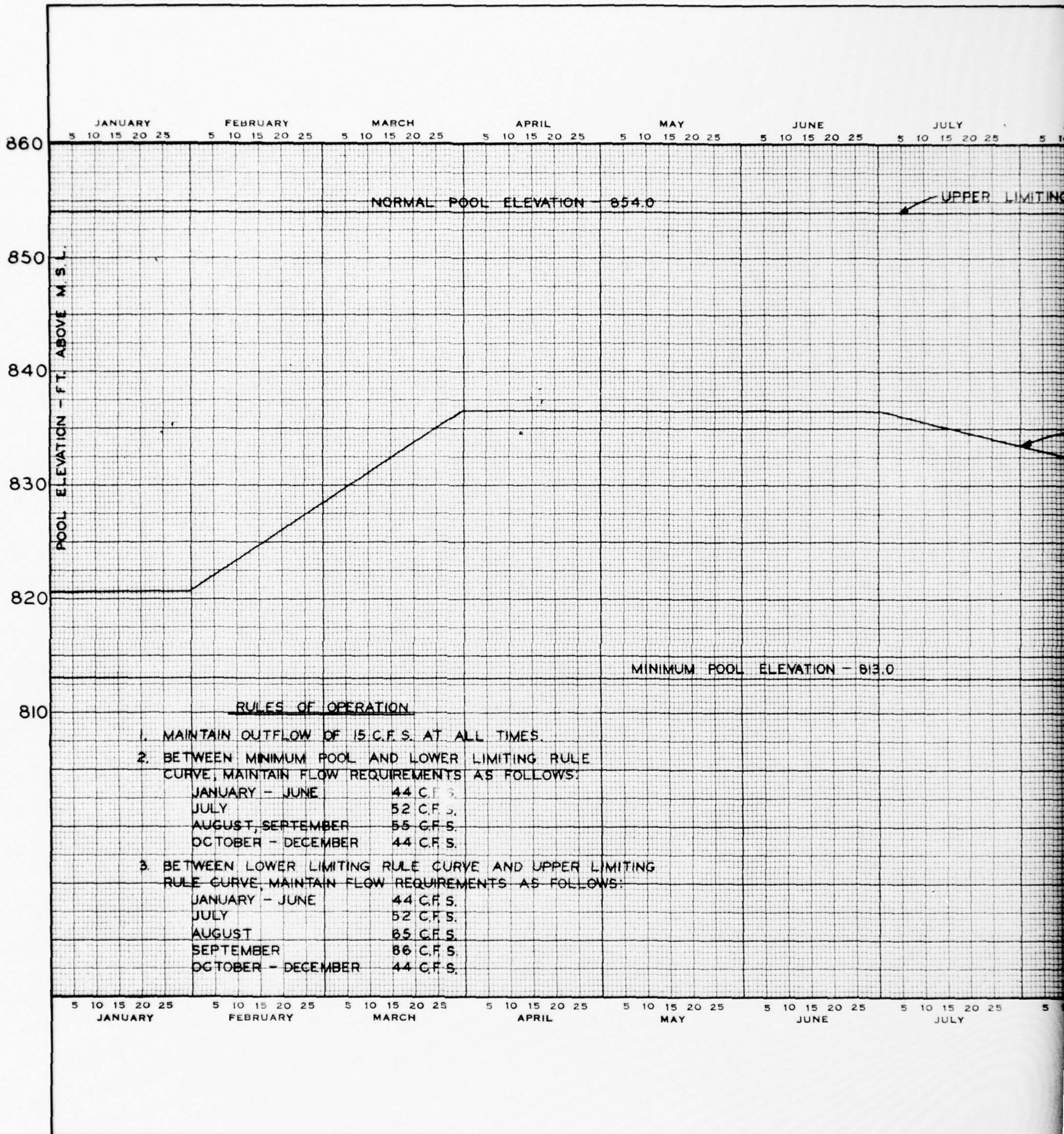
For Year 2020 - Drawdown in Feet

Exceedence - Year	June	July	August
1	0	0	0
2	0.1	0.5	1.3
5	0.5	1.4	2.4
10	0.9	2.1	3.2
20	2.3	3.4	4.3

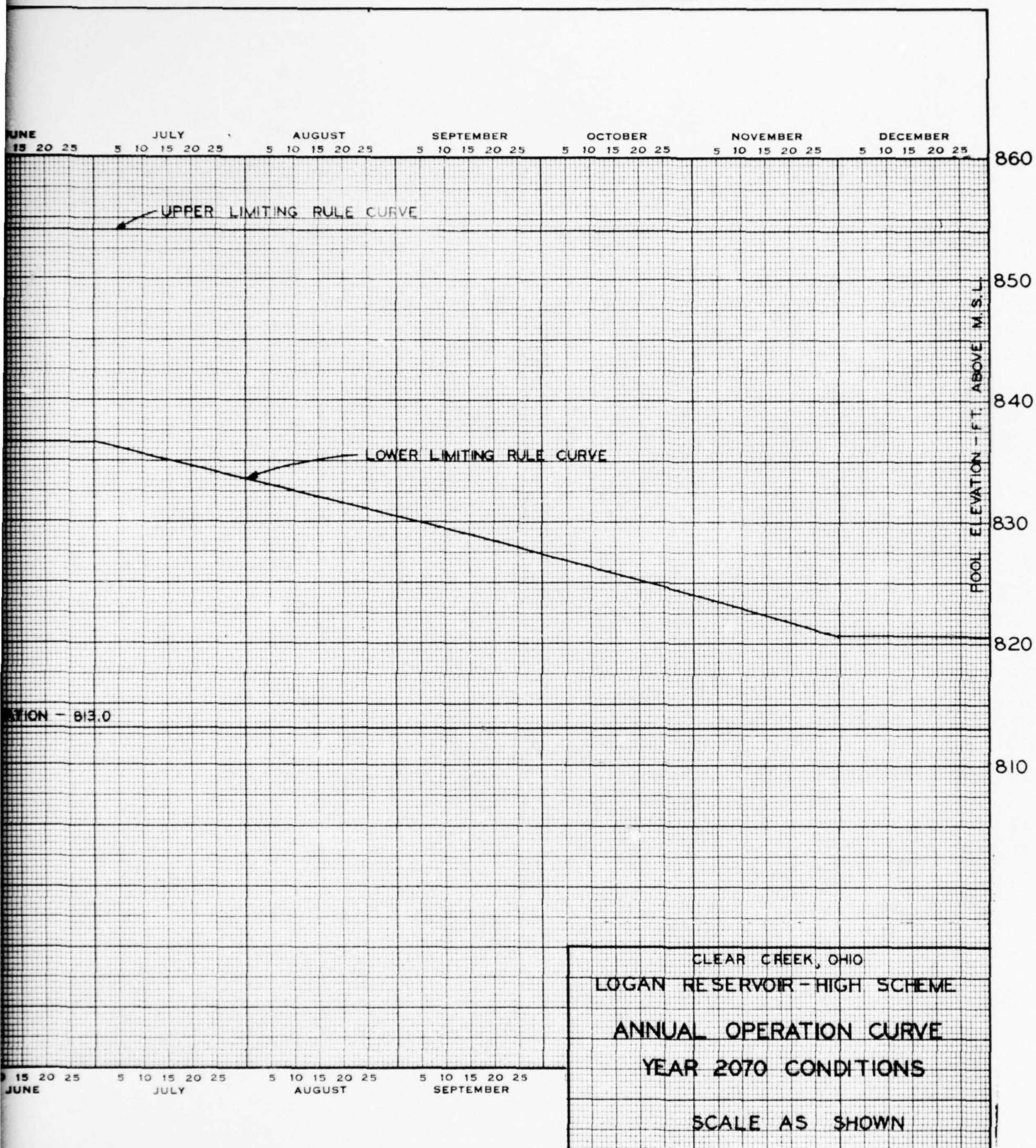
For Year 2070 - Drawdown in Feet

Exceedence - Year	June	July	August
1	0	0	0
2	0.3	1.3	3.1
5	1.3	3.8	5.4
10	2.4	6.8	7.8
20	5.1	11.9	14.5

CORPS OF ENGINEERS



DEPARTMENT OF THE ARMY



CLEAR CREEK, OHIO

LOGAN RESERVOIR - HIGH SCHEME

ANNUAL OPERATION CURVE

YEAR 2070 CONDITIONS

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W.VA. JUNE 1967

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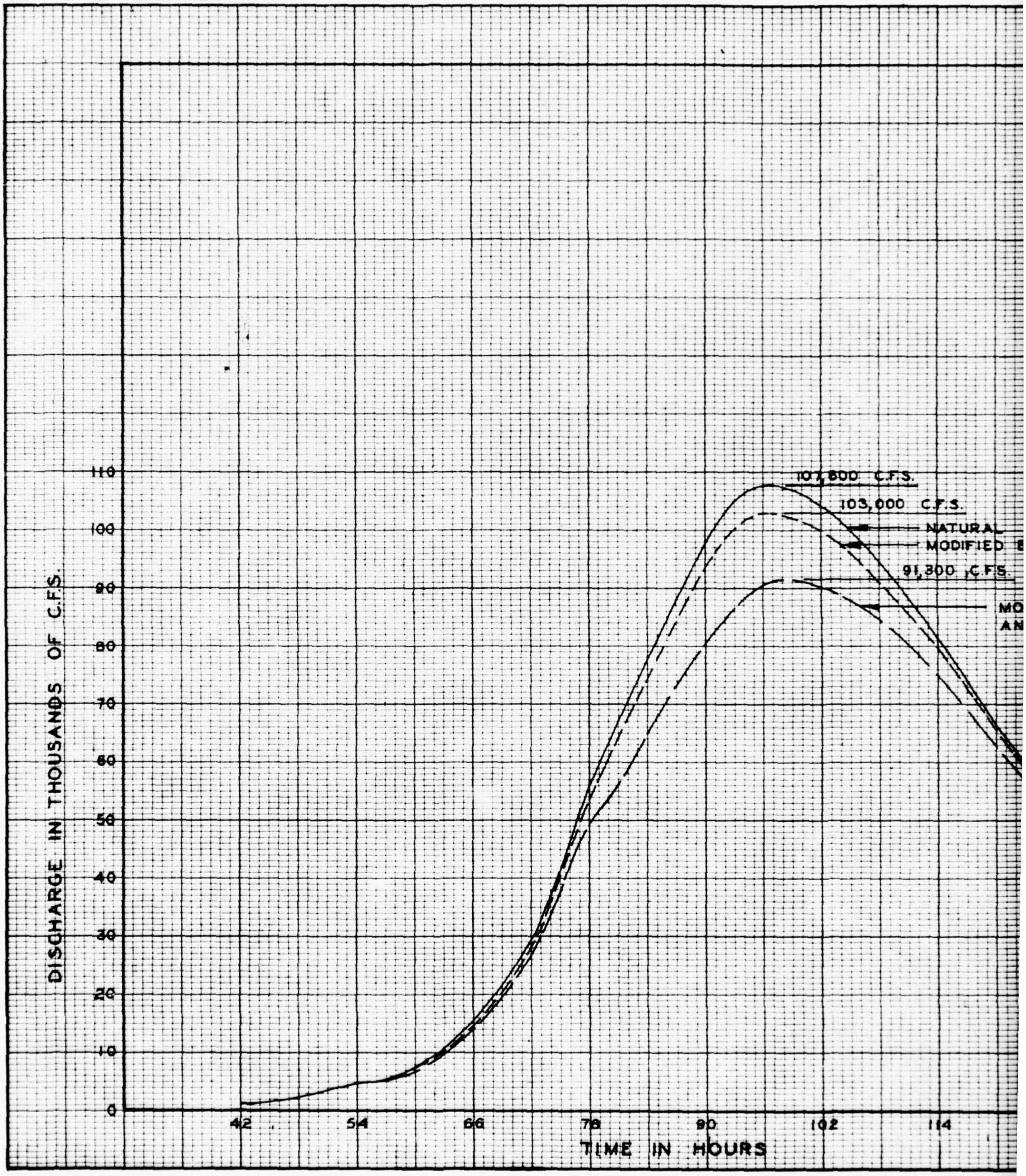
CORPS OF ENGINEERS



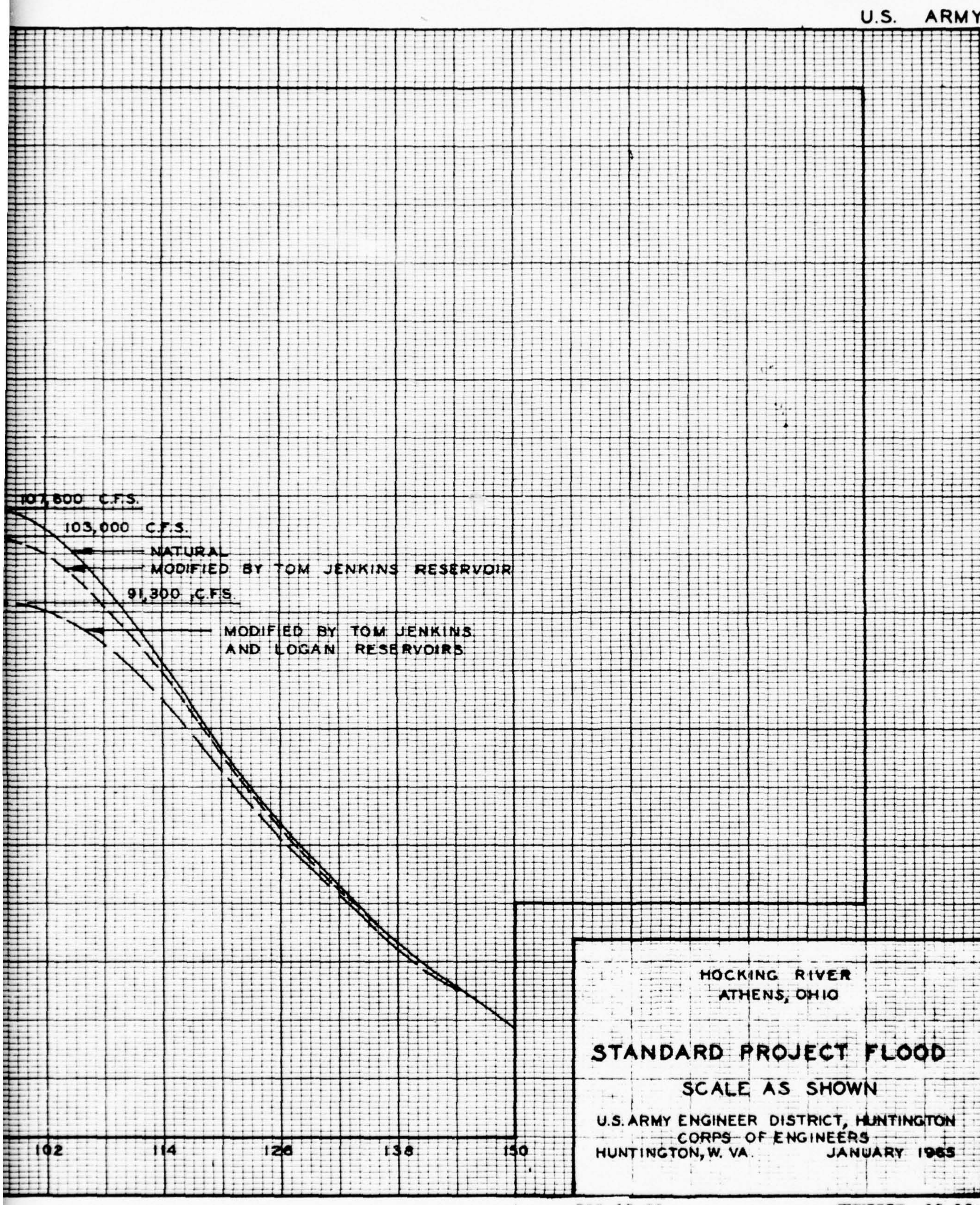


EXHIBIT 15-13

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Hydraulic design of reservoir (general). The hydraulic design studies for the project included the determination of sizes of spillway and outlet works and elevations for the proposed dam. The hydraulic computations conform to the usual procedures for designs of this type, and were supplemented by data contained in Civil Works Manuals, Hydraulic Design Charts, and completed model studies on similar projects.

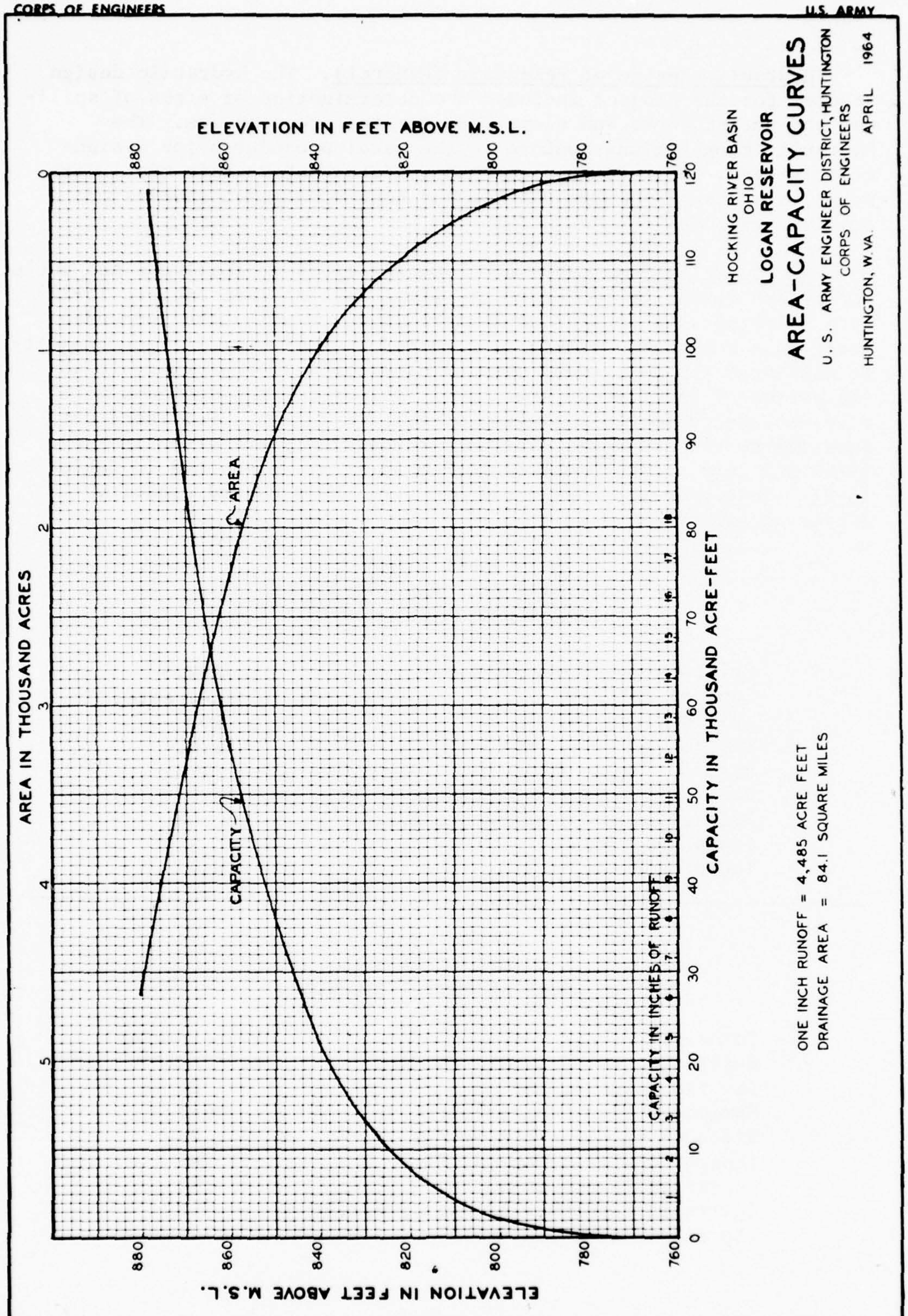
Reservoir design. Various sizes and types of spillways and outlet works were investigated before the final designs (see exhibit 15-22) were selected. The outlet works were sized to empty the impounded water in a reasonable length of time and also with sufficient capacity to discharge the downstream channel capacity with the reservoir at the bottom of the flood control pool. Diversion requirements were also considered in the selection of the final size. Pertinent data relative to the hydraulic design of the spillway are given in Table 15-20 and data on the proposed outlet works are presented in Table 15-21. The reservoir design was based on the area and capacity curves on exhibit 15-14.

TABLE 15-20
SPILLWAY DATA AND TOP OF DAM
LOGAN RESERVOIR PROJECT

Spillway crest el., m.s.l.	868.3
Type of spillway	Broad-crested
Spillway length, ft.	100
Maximum pool el., m.s.l.	884.4
Head on crest, ft.	16.1
Peak inflow (s.d.f.), c.f.s.	83,600
Peak spillway discharge, c.f.s.	18,400
Freeboard, ft.	5.6
Top of dam el., m.s.l.	890

TABLE 15-21
OUTLET WORKS DATA
LOGAN RESERVOIR PROJECT

Tunnel size, ft.	10 (circular)
Regulating gate, number and size	2-5'8"x10'0"
Low flow sluice, in.	24
Maximum outlet capacity, c.f.s.	4050
Width of stilling basin, ft.	28
Length of sloping apron, ft.	46
Length of level basin, ft.	46
Invert el. (bottom) of basin, m.s.l.	763
Top el. of training walls	784


ELEVATION IN FEET ABOVE M.S.L.
880
860
840
820
800
780
760
AREA IN THOUSAND ACRES
0
1
2
3
4
5
CAPACITY IN THOUSAND ACRE-FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
CAPACITY IN INCHES OF RUNOFF
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
AREA
CAPACITY
HOCKING RIVER BASIN
OHIO
LOGAN RESERVOIR
AREA-CAPACITY CURVES
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA. APRIL 1964
ONE INCH RUNOFF = 4,485 ACRE FEET
DRAINAGE AREA = 84.1 SQUARE MILES

11. GEOLOGIC

This paragraph presents the general geology of the Hocking River Basin and preliminary geology and soils data for Logan Dam site. Logan Dam site is located on Clear Creek, a major tributary of the Hocking River in the general vicinity of the city of Logan, Hocking County, Ohio. The information presented includes data obtained by geological reconnaissance, subsurface exploration, and research of documentary literature.

Physiography and topography - The Hocking River rises approximately 35 miles southeast of Columbus, Ohio, near the town of Canal Winchester at the Franklin-Fairfield County line. From this point at an elevation of 1100 feet above mean sea level, the stream flows in a southeasterly direction to its junction with the Ohio River at Hockingport, Ohio. The elevation at its confluence with the Ohio River is 552 feet above mean sea level making a total fall of 548 feet. The Hocking River is 94.5 miles in length, has an average slope of 4.75 feet per mile, and drains approximately 1,180 square miles. Most of its course is through a broad flat valley averaging 1/2 mile in width, which is subject to frequent flooding. This valley is cleared and generally under cultivation.

The Hocking River watershed lies wholly within the Appalachian Plateau Physiographic Province, Kanawha Section. This section is characterized by a mature plateau of fine texture with moderate to strong relief. The total relief of the region generally exceeds 500 feet. The plateau surface is about 1,100 feet above mean sea level and is now in evidence only along the summits of the main ridges of the area.

The Hocking River watershed, which embraces major portions of Fairfield, Perry, Hocking and Athens Counties and small portions of Meigs, Morgan and Washington Counties, is divided topographically into two regions by glaciation. The upper reaches of the Hocking River have been glaciated and are characterized by low, gently sloping hills and broad, flat valleys. The topography of the central and lower reaches has not been affected by direct glaciation and differs markedly with the upper reaches. At the margin of the glaciated area, approximately two miles upstream of the Logan Dam site, the valley of the main stream narrows conspicuously, the slopes steepen, and the relief becomes greater. The glaciated area is fairly well dissected near its margin, exhibiting rolling, moderately steep hills and broad valleys. Above this transitional zone the rolling upland surface becomes smoother and the valleys widen toward the north. Heavy glacial drift characterizes this area and in some places the drift completely obscures the bedrock in hills and valleys. Below this transition zone the valleys are filled with considerable thicknesses of glacial outwash materials. The area now drained to the southeast by the Hocking River originally drained to the northwest. This former stage drainage, called the Haydensville River, was blocked by the Illinoian Ice Sheet, Scioto Lobe, and its flow reversed to the present Hocking River course with associated glacial and glacial outwash deposition.

Stratigraphy - The Hocking River flows in a southeasterly direction dissecting sedimentary strata of Permian, Pennsylvanian, and Mississippian Age. These great thicknesses of shallow-water sediments are now exposed in Ohio as parallel, elongated belts trending in a northeast to southwest direction. The strata includes, in descending geologic order, the Greene, Washington, Monongahela, Conemaugh, Allegheny and Pottsville formations of Permian and Pennsylvanian Age and the Waverly series of Mississippian Age. The Hocking River Basin for the most part is imbedded in Pennsylvanian Age strata. The Mississippian is found only in the upper reaches of the stream and the Permian is present for approximately ten miles near the confluence of the stream with the Ohio. Exhibit 15-15 is a geologic map of the Hocking Basin.

Structural geology - The flow of the Hocking River and its tributaries has not been noticeably affected by geologic structure. The bedrock of eastern Ohio, including that of the Hocking Valley, forms part of the eastern flank of the Cincinnati Anticline. This arch was formed contemporaneously with the subsidence of the Appalachian Geosyncline and has so influenced the strata as to give it a general southeasterly dip towards the axis of the geosyncline. The normally gentle slope of one degree or less is interrupted only locally by smaller scale structures such as the Cambridge Arch and the Parkersburg-Lorain Syncline. Neither of these structures affects the strata of the Hocking River Valley.

Site geology - Logan Dam site is located on Clear Creek near the Hocking-Fairfield County line, approximately 4 miles west of the town of Rockbridge, Ohio. Clear Creek is the largest of the easterly flowing tributaries of the Hocking River and enters the main stream 73.6 miles above its mouth. From its source near the town of Royalton in Fairfield County at an elevation of 1090 feet above sea level, Clear Creek flows 23.7 miles to its confluence with the Hocking River at an elevation of 746 feet above mean sea level. The average fall for its entire length is 14.5 feet per mile. The stream is comparatively straight except in western Fairfield County where the course is winding. The upper and middle reaches of the valley are comparatively wide converging into a narrow gorge near its confluence with the Hocking River. The stream flows at an elevation of 778 feet above sea level at the dam site with ridges in the vicinity reaching 1160 feet above sea level making a total relief of 380 feet. Clear Creek flows over the Waverly Series of Mississippian Age throughout its entire length. No mineral resources of economic importance are found within the reservoir area.

The rock at Logan Dam site is included in its entirety in one member of the Cuyahoga Formation. This member, the Black Hand sandstone, is greatly elongated with a bar-like configuration. Its axis trends slightly west of north. To the east and west it interfingers with other members of the Cuyahoga. All structures associated with the dam and appurtenant works will be founded in this member. Much

higher on the ridges in the area of the dam this member is overlain disconformably by the siltstones and sandstones of the Logan member. The rock of the Black Hand sandstone at the dam site is characterized by very deep and severe weathering. It is essentially a massive medium grained, micaceous and conglomeratic sandstone. Subsurface explorations, however, revealed its leached condition and the great number of clay lenses and layers present along minor bedding planes. The spillway channel and the dam core trench will be founded on this member. The outlet works will also be driven through and founded upon this sandstone. Due to the steepness of the slopes on the abutments, the thickness of soils rarely exceeds 5 feet. A reversal in direction of flow following the Illinoian stage glacial advance cut a deep gorge now followed by Clear Creek. Glacial outwash then filled this gorge forming the buried valley conditions now present at the dam site. The outwash material is composed of 60 to 65 feet of silty sand and gravel. This material is overlain by 5 to 10 feet of alluvial silts and sands. Due to the massiveness of the Black Hand sandstone, there is no continuous evidence of any appreciable dip in the strata. Also, due to the weathering characteristics of this sandstone, no major joint systems could be distinguished in outcrops within the reservoir area.

Subsurface investigations. Subsurface investigations included drive sampling of overburden, drilling without sampling and NX size rock core drilling. The locations of all exploratory borings are shown on Exhibit No. 15-17. One drive sample boring was made at the spillway site to determine the thickness and type of overburden present. In addition, drive samples were obtained from borings C64-2, C64-3 and C64-4 at the dam location. Samples were taken at three-foot intervals or with every change in material and were classified in the field and at the District Office. One hole near the proposed dam axis, D64-2, was drilled with a fishtail bit to determine top of rock. No samples were taken. Also in holes C64-2, C64-3 and C64-4, drilling without sampling was performed to the top of rock where samples of the materials could not be recovered below the water table. Five NX size core borings were made to investigate foundation conditions at the dam, spillway and tunnel locations. Detailed logs of the recovered cores were made. Exhibit 15-18 shows graphic logs of all holes. No pressure testing was performed.

Foundation conditions and treatment.

Dam - Three NX size core borings C64-2, C64-3 and C64-4, were made at the location of the original dam axis. These were drilled to determine the character of the foundation rocks and the character and thickness of the materials in the buried valley. The foundation rock is the sandstone of the Black Hand member as previously discussed. The sandstone is less severely weathered under the valley than was evidenced on the slopes above. Another NX size boring was drilled on the right abutment at the location of the intake structure of the

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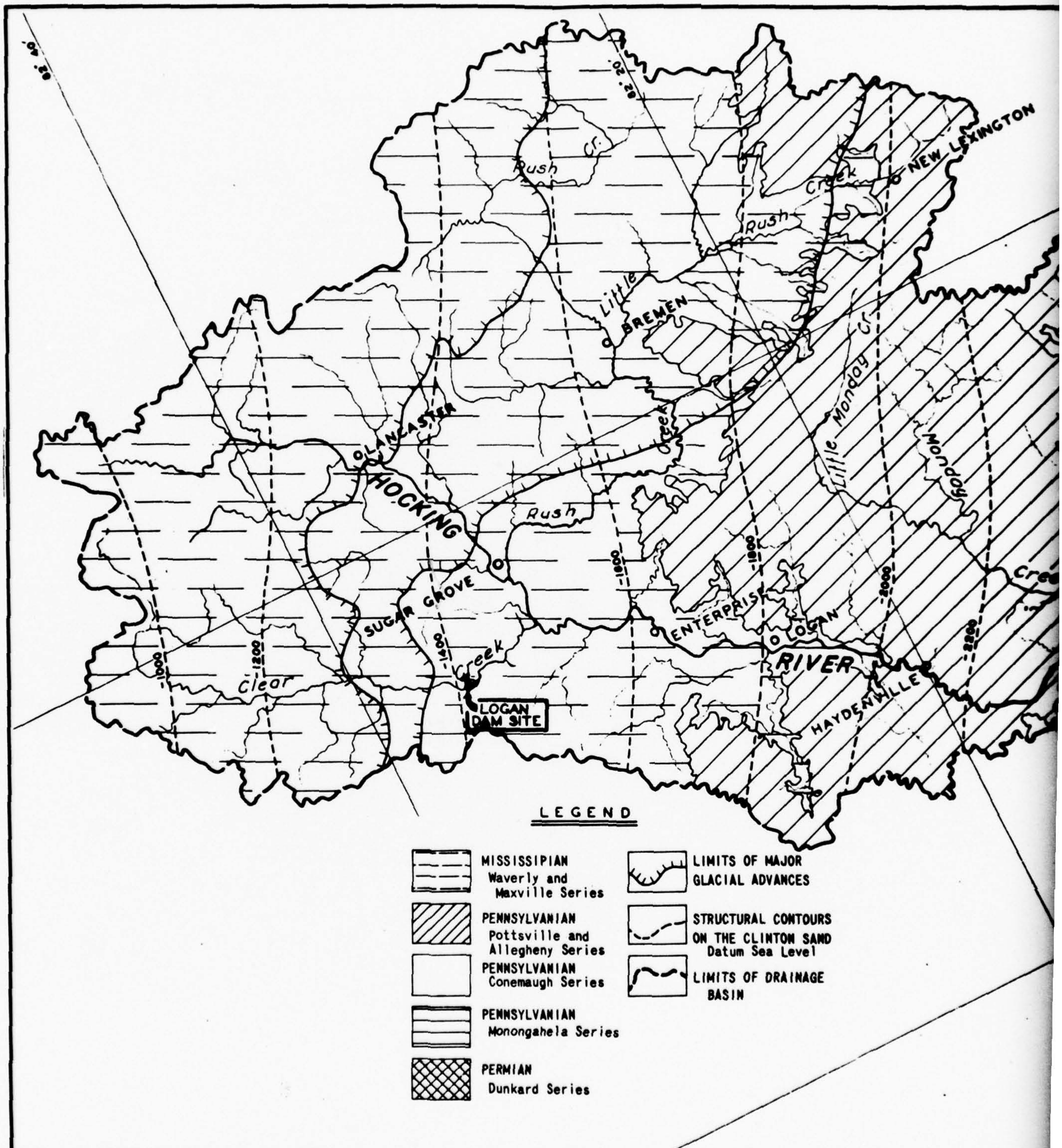

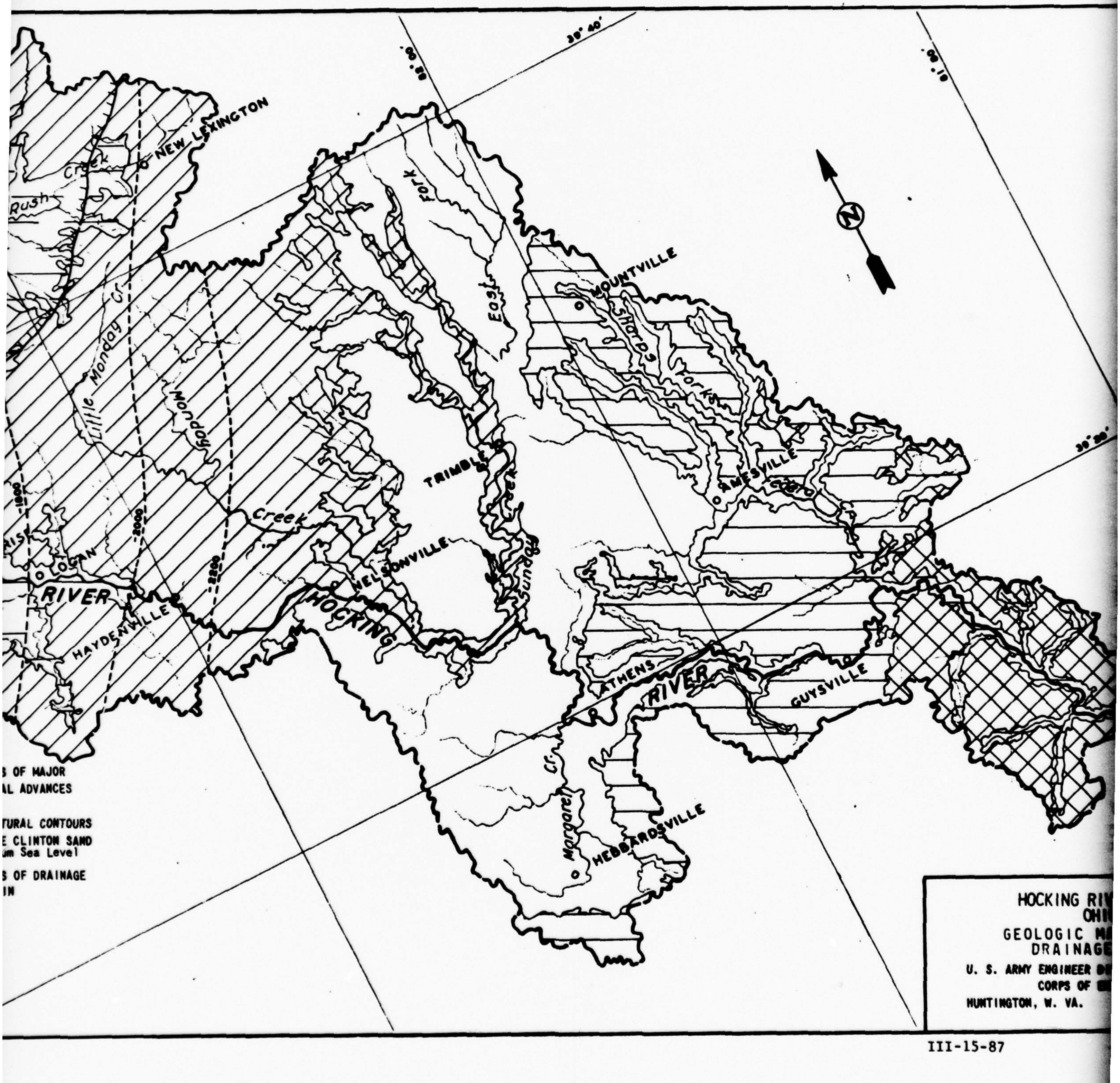
NEW LEXINGTON
Rush Creek
Little Monday Cr.
Monday Creek
MOUNTVILLE
East Fork
Sharps Fork
TRIMBLE
AMESVILLE
NELSONVILLE
Sunday Creek
LOGAN
RIVER
HAYDENVILLE
HOCKING
ATHENS
RIVER
GUYSVILLE
Margaret Cr.
HEBBARDSVILLE
1000
2000
2200
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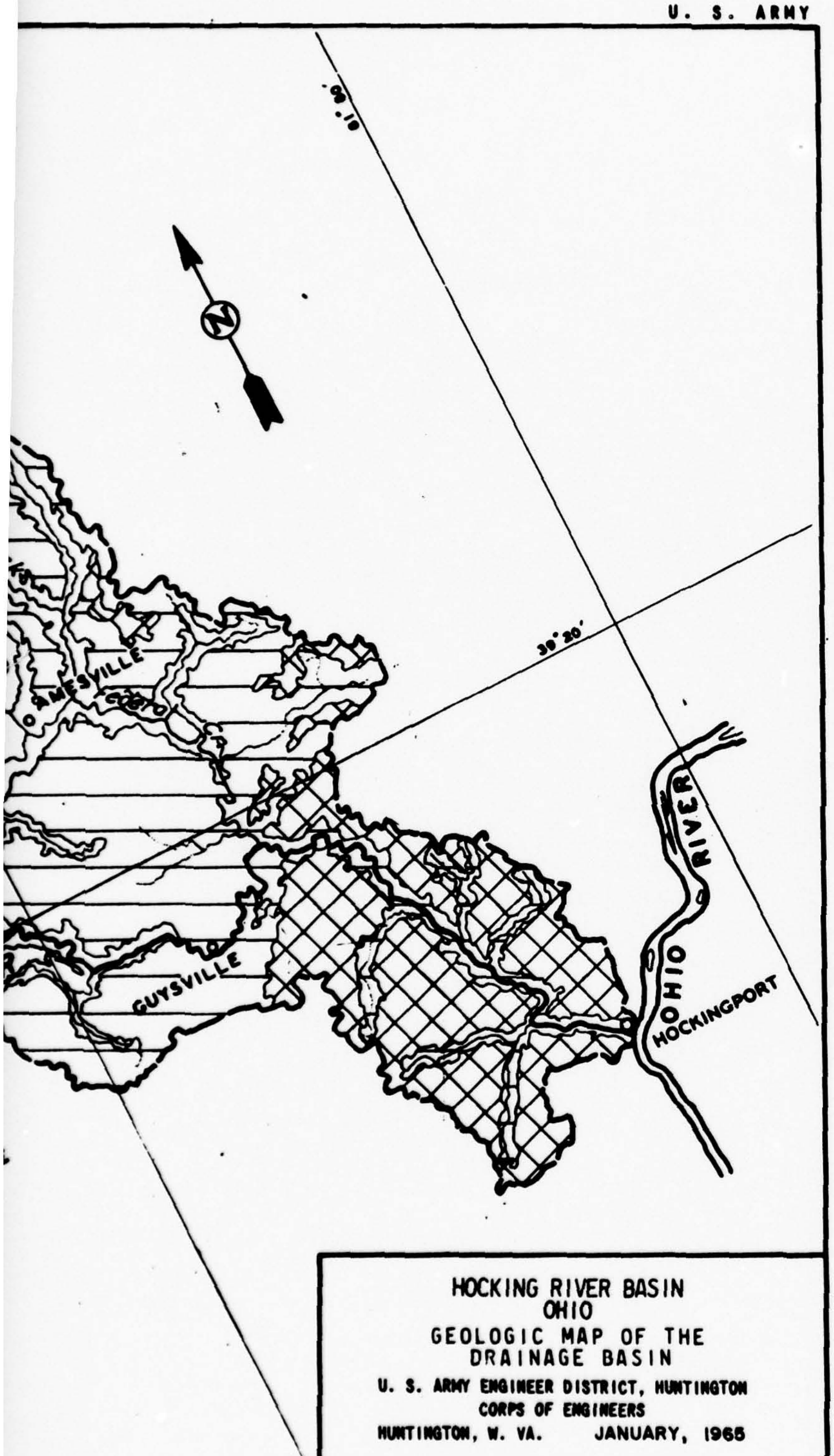

AMESVILLE
GUYSVILLE
39°20′
81°00′
OHIO RIVER
HOCKINGPORT
HOCKING RIVER BASIN
OHIO
GEOLOGIC MAP OF THE
DRAINAGE BASIN
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA. JANUARY, 1965

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LEGEND

ABBREVIATIONS

a.	angle
ar.	argillaceous
aren.	arenaceous
b.	bone
bd	bed(ded)(ing)
bf.	buff
bk.	black
bkn.	broken
bl.	blue
bot.	bottom
brc.	breccia(ted)
br.	brown
c.	coarse
ca.	calcareous
carb.	carbonaceous
cl.	clayey
cle.	clean
comp.	compact
conc.	concretion
cong.	conglomeratic
cont.	contains
cr.	crushed
cst.	crystal(line)
cem.	cement(ed)
cav.	cavity, cavern
di.	dirty
dia.	diameter
diag.	diagonal
dis.	disintegrated
diss.	disseminated
dk.	dark
dn.	dense
f.	fine
fer.	ferruginous
fis.	fissile
fil.	filled(ing)
fos.	fossil(iferous)
frac.	fracture(d)
frags.	fragment(s)
fri.	friable
g.	grain(ed)
gn.	green
gr.	gray
gra.	gravelly
grad.	grading(ed)
h.	hard
hi.	high(ly)
hor.	horizontal(ly)
inc.	included, inclusions
inla.	interlaminated
int.	intercalations
intbd.	interbedded
jt.	joint(ed)
l.	little
lms.	laminat(ions)(ed)
lay.	layer(s)
le.	lean
len.	lense(s)
lt.	light

m.	medium & or moderately
ma.	many
mas.	massive(ly)
mat.	material
mic.	micaceous
n.	near
num.	numerous
o.	open
org.	organic
pa.	parting(s)
part.	particle(s)
pl.	plane(s)
peb.	pebble(s)
pk.	pink
po.	porous
pt.	part
pyr.	pyrite(d)(ic)
q.	quartzitic
r.	red
ro.	rock(s)
rou.	round(ed)
s.	soft
sa.	sandy
se.	seams
sev.	severely
sh.	shaly
sil.	siliceous
sl.	silty
sli.	slight(ly)
slk.	slickensided
sm.	small
so.	some
sta.	stain(ed)
stks.	streak(s)
str.	stringer(s)
sty.	styolit(e)(ic)
t.	thin
tk.	thick
tr.	trace
v.	variably
va.	varigated
ve.	very
veg.	vegetation
ver.	vertical(ly)
vu.	vuggy
/	with
wd.	weathered
x.	cross bedded(ing)
y.	yellow
zo.	zone

ROCK

Symbol	Name	Abbreviation
	Sandstone	SS.
	Conglomerate	CONG.
	Shale	SH.
	Siltstone	SLS.
	Claystone	CLS.
	Limestone	LS.
	Coal	C.
	Indurated Clay	ICL.
	Dolomite	DO.

OVERBURDEN

Symbol	Name	Abbreviation
	Unclassified	UN.
	Topsoil	T.
	Clay	CL.
	Silt	SL.
	Sand	SA.
	Gravel	GR.
	Boulders	BOU.
	Sand, Gravel & Occasional Boulders	

MISCELLANEOUS

◄ G.W. Ground water level (date)

✳ L.D.W. Lost drill water (percent)

ROCK HARDNESS

Soft - Can be scratched with fingernail.

Moderately hard - Can be scratched easily with knife; cannot be scratched with fingernail.

Hard - Difficult to scratch with knife.

Very hard - Cannot be scratched with knife.

HOCKING RIVER BASIN
OHIO

LEGEND

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
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HUNTINGTON, W.VA. JANUARY, 1968

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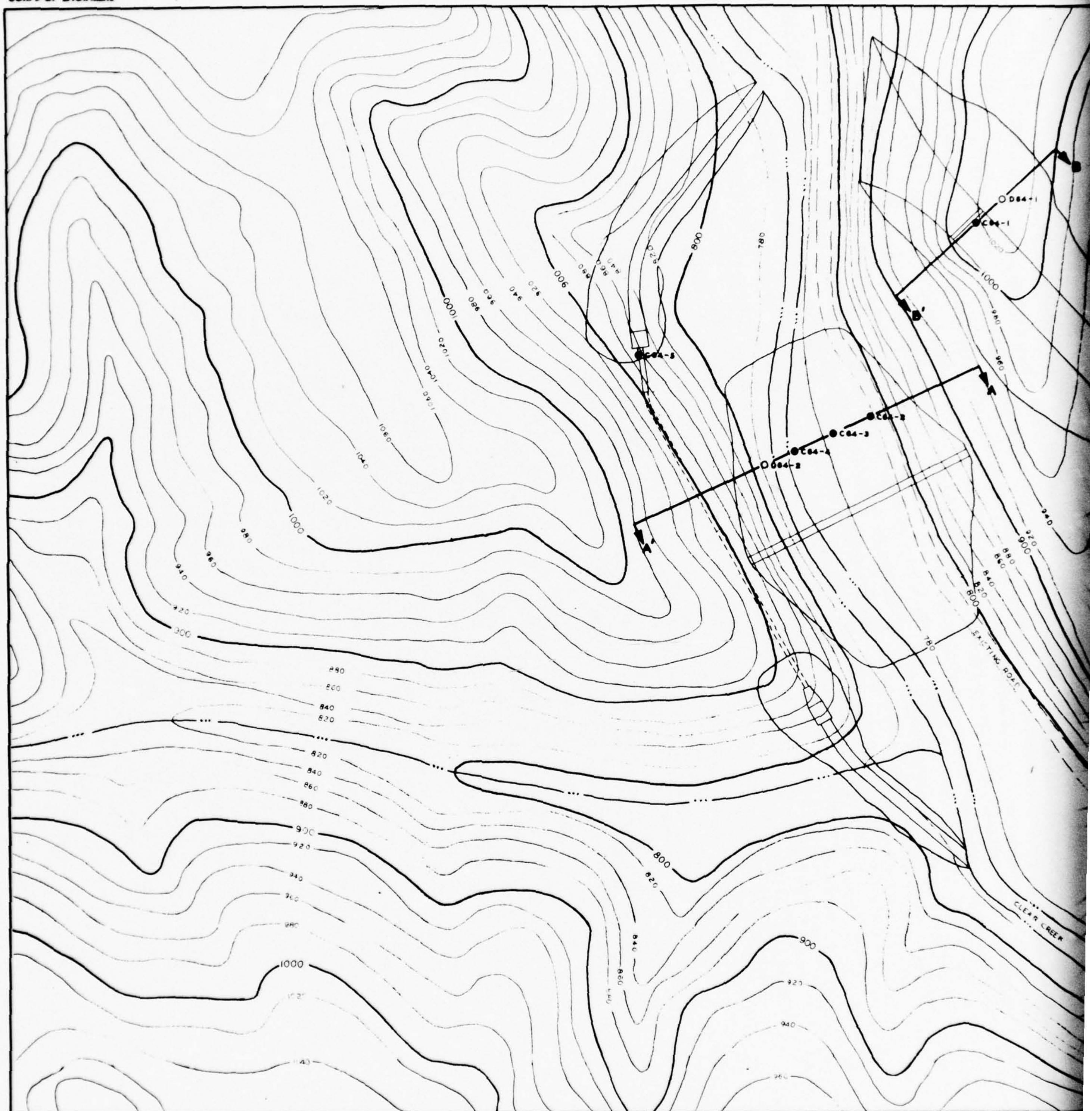

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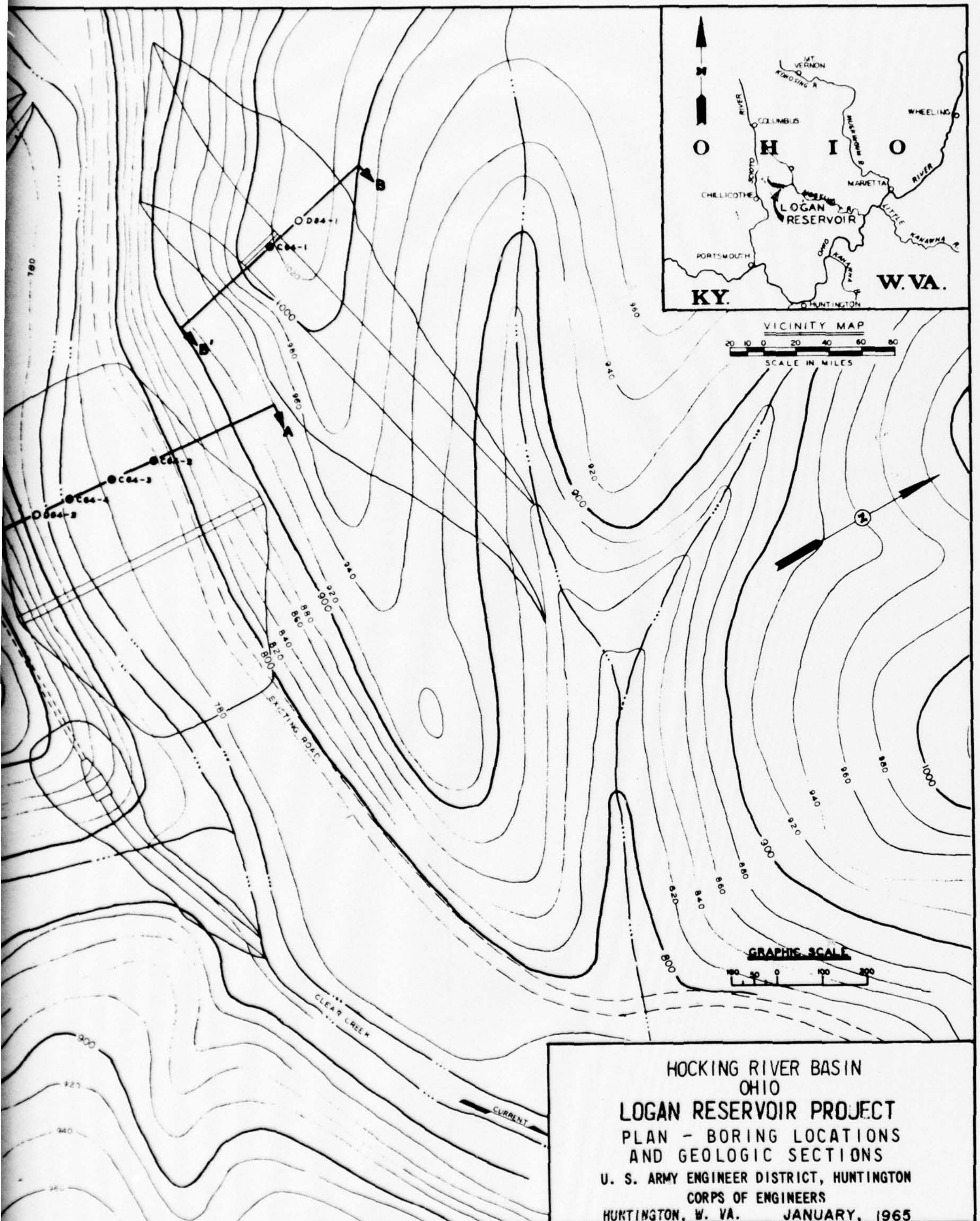

HOCKING RIVER BASIN
OHIO
LOGAN RESERVOIR PROJECT
PLAN - BORING LOCATIONS AND GEOLOGIC SECTIONS
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA. JANUARY, 1965

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C 64-1
6-64

ELEV	SYM	CLASSIFICATION	REMARKS
1008.8			Top of Rock
		SS.,s.,f. to m.g.,br.,sev. wd.,bkn./ CL. len.	Loss 1.7
			Loss 1.2
		0.2' fer. banding @ El. 1004.8	Loss 0.0
		0.1' CL.,tan @ El. 1001.4	Loss 0.0
		0.2' CL.,tan @ El. 1001.0	
		0.1' CL.,tan @ El. 998.1	Loss 2.0
			Loss 3.7
		SS.,s.,m. to c.g.,br.,sev. wd.,bkn./ cong. zo.	
986.7		SS.,cong.,s.,m. to c.g.,br., sev. wd.,bkn.	Loss 4.4
982.5		0.4' fer./ very large cl. fil. voids @ El. 981.3	Loss 0.4
979.2		0.1' CL.,red @ El. 979.2	
		SS.,s.,f. to m.g.,br.,sev. wd.,bkn./ cong. zo. @ ma. CL. se.	Loss 2.0
		0.1' CL., tan @ El. 976.6	Loss 2.0
		0.1' iron oxide se. @ El. 972.4	
		1.2' CL.,dk.gr. to br./ 0.2' SS. @ El. 972.1	Loss 2.1
		0.2' CL., tan @ El. 970.4	
		0.6' CL.,dk.gr. @ El. 966.0	
960.0		0.2' CL.,dk.gr. @ El. 965.2	
		0.8' CL.,dk.gr. @ El. 964.4	
		large CL. fil. void @ El. 961.2	Loss 2.8
955.2			@ L.D.W.
		SS.,cong.,s.,br.,sev. wd., bkn.	Loss 1.2
950.2			
		CONG.,sa.,s.,br.,sev. wd., bkn. (40% SA.)	
		SS.,s.,f. to m.g.,br.,wd. bkn./ cong. zo's. & ma. CL. se.	Loss 1.9
		a frac.,CL., fil. @ El. 941.4	
		0.6' zo.,CL., fil. fracs. @ El. 940.5	
		0.2' CL.,r. @ El. 938.6	
		CONG. zo. @ El. 939.6 to 935.6	
		0.2' CL.,r. @ El. 935.4	Loss 2.9
		0.2' CL.,br. @ El. 931.7	
		0.2' CL.,br. @ El. 931.2	
		0.6' CL.,len.,tan @ El. 926.7	
		0.2' sm. CL. fil. voids @ El. 925.6	Loss 1.0
		0.3' CL.,tan @ El. 924.2	
917.9			
			Loss 3.5
		SS.,cong.,m. to c.g.,s.,br., sev. wd.,bkn./ approx. 25% CL. len. & nodules	
			Loss 6.7
900.4		SS.,s.,f. to m.g.,r. & br., sev. wd.,bkn./ iron oxide se. & ma. CL. len.	
		0.2' CL.,tan @ El. 900.4	
893.2		0.1' CL.,tan @ El. 898.6	Loss 4.8
		SS.,s.,f. to m.g.,br.,sev. wd.,bkn./ 10-15% CL. as tan len. up to 0.3' tk. & nodules	
		SS.,s.,f. to m.g.,r. & br., sev. wd.,bkn./ ma. CL. len. & iron oxide se.,cross-bd.	Loss 1.4
879.4			
		CL. fil. pa. @ El. 878.9	
		0.2' zo. of CL. len. @ El. 877.3	
873.2			Loss 0.5

C 64-2
6-64

ELEV	SYM	CLASSIFICATION	REMARKS
782.6			
777.6		SA.,sl.,br.,dry / tr. CL.	
771.6		SA.,sl.,br.,damp / tr. CL.	◄ G.W.
768.6			
765.6		SA. & GR.,sl. & cl.,damp	
759.8			Top of Rock
754.6		SS.,s.,m. to c.g.,r. & br., sev. wd.,bkn./ cong. zo's.	Loss 2.9

◄ G.W. @ EL. 771.7 6-25-64

C 64-4
6-64

ELEV	SYM	CLASSIFICATION	REMARKS
778.6			
773.6		SA.,cl.,br.,damp/ tr. sl.	
770.6		CL.,sa. & sl.,br.,damp	◄ G.W.
764.6		SA. & GR.,sl. & cl.,damp	
710.7		SS.,s.,f. to m.g.,br. to r., cross-bd.,sev. wd.,bkn., iron oxide se. @ El. 708.2	Top of Rock
708.1			
705.4		SS.,w.h.,f. to m.g.,gr./ num. CL. len. & nodules	Loss 0.5

◄ G.W. @ EL. 771.7 6-28-64

C 64-5
7-64

ELEV	SYM	CLASSIFICATION	REMARKS
866.1			
856.7			Top of Rock
		SS.,s.,f. to m.g.,r. & br., fri.,wd.,bkn.,cross-bd., / ma. CL. nodules & len.	Loss 0.7
			Loss 1.2
		0.2' CL.,tan @ El. 844.3	* L.D.W.
		0.1' CL.,tan @ El. 843.2	
		0.1' CL.,tan @ El. 839.6	
			Loss 0.3
		0.5' CL.,nodules & len. @ El. 832.1	
		0.1' CL.,r. @ El. 829.8	
		0.6' zo. CL.,len. @ El. 827.0	
		0.6' zo. frac's./ t. CL. len's. & nodules @ El. 816.8	
		0.3' zo. CL. nodules @ El. 813.1	
		0.3' zo. CL. nodules @ El. 812.0	
		0.2' CL.,br. @ 808.1	
		0.1' CL.,tan @ El. 804.2	Loss 0.3
		0.3' CL.,nodules @ El. 804.1	
794.6			

D 64-1
6-64

ELEV	SYM	
1029.7		
1021.7		CL...

U.S. ARMY

C 64-2
6-64

ELEV.	SYM	CLASSIFICATION	REMARKS
782.6			
777.6		SA., sl., br., dry / tr. CL.	
771.6		SA., sl., br., damp / tr. CL.	◄ G.W.
768.6			
765.6		SA & GR., sl. & cl., damp	
759.8			Top of Rock
754.6		SS., s., m. to c.g., r. & br., sev. wd., bkn. / nong. zo's.	Loss 2.8

◄ G.W. @ EL. 771.7   6-25-64

C 64-3
6-64

ELEV.	SYM	CLASSIFICATION	REMARKS
780.8			
772.8		SA., sl., br., damp	
769.8		SA. & GR., sl., br. / large rou. GR., very damp	◄ G.W.
766.8		SA & GR., sl., br., wet / tr. CL & large rou. GR.	
754.8		SA & GR., sl. / sli. tr. cl. damp	
710.7			Top of Rock
678.8		SS., s., lt. to dk. br., f. to m.g., sli. mic., m. wd. & bkn. zo. of sm. CL. len. @ El. 689.4 pa. at CL. len. @ El. 688.5 1.6' zo. / ma. CL. len. & nodules @ El. 686.6 few CL. nodules @ El. 683.1 to 682.1	Loss 0.7 Loss 0.6 Loss 0.3 Base of m.wd. at El. 680.1 Loss 0.6

◄ G.W. @ EL. 771.4   6-23-64

D 64-1
6-64

ELEV.	SYM	CLASSIFICATION	REMARKS
1029.7			
1021.7		CL., sa., br. / wd. SS. frags.	

NOTE: INCREMENTS OF LOGS FOR WHICH NO CLASSIFICATION IS LISTED SIGNIFY ZONES IN WHICH NO SAMPLES WERE OBTAINED.

HOCKING RIVER BASIN
OHIO
LOGAN RESERVOIR PROJECT
GRAPHIC LOGS
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, W. VA.   JANUARY, 1965

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outlet works. The core taken from this boring reflected the deep severely weathered character of the rocks forming the dam abutments. A core trench will be excavated into rock along the entire length of the dam section. Below the core trench a grout curtain will be developed. It is probable that a large amount of grout will be required to obtain positive cutoff. Exhibit 15-19 is a geologic section through the dam.

Outlet works - One NX size core boring, C64-5, was drilled on the centerline of the proposed tunnel near the intake structure. The tunnel will be driven through the severely weathered Black Hand sandstone previously mentioned and the intake and outlet works will be founded on this same member. The roof of the concrete lined tunnel will require support by structural steel ribs or rock bolts.

Spillway - Borings C64-1 and D64-1 were drilled at the proposed spillway site. The entire spillway cut will be made in the Black Hand sandstone and the spillway channel will be founded in this same member. The integrity of the spillway crest in this weathered sandstone will be protected by a broadcrested weir. The slopes adjacent to this weir are paved up to 20 feet above crest elevation to protect against side channel scour. Approximately 320,000 cubic yards of the sandstone excavated from the spillway will be used in the rolled random section of the proposed dam design. Exhibit 15-20 is a geologic section through the spillway crest.

Leakage conditions - The rim-rock of Logan Reservoir is mainly within the massive Black Hand sandstone of the Cuyahoga Formation. No major problems in reservoir leakage are expected although the Black Hand sandstone exhibits marked differential weathering along bedding planes. The bedding planes of this formation contain accumulations of clays and silts and some iron oxide deposits. A grout curtain will be formed in the rock in the foundation and abutments at the dam site to control leakage at the site. A review of reservoir topography reveals no low or narrow divides which would drain the proposed reservoir. Due to the potentially pervious character of the sands and gravels underlying the dam site, an impervious core extending to rock, in conjunction with the aforementioned grout curtain, has been proposed to provide positive cutoff of underseepage. Ground water levels were not recorded during subsurface investigations of the dam abutments. It is felt that these levels will be low but further investigations will be required to determine whether or not this level is low enough to become a leakage problem.

Construction materials - A total of 368,000 cubic yards of random material, 450,000 cubic yards of impervious material, 21,000 cubic yards of dumped riprap material and 127,000 cubic yards of transition and blanket drain materials will be required for construction of the Logan Dam. All random material will be available from the spillway excavation. Geologic reconnaissance of the

uplands in the vicinity of the dam site, which included very limited hand augering of soils, indicates impervious materials are present in sufficient quantities. A borrow area, located on ridges north of the dam site and the Clear Creek Nature Area has been tentatively chosen as a source of impervious material. Construction haul roads will be located with a view to later incorporation into parking areas and access and circulation roads. Riprap materials and concrete aggregate sources are present commercially within a 50-mile radius of the dam site. The materials needed for transition and blanket drain construction could possibly be obtained by stockpiling and processing of sands and gravels removed from the valley during construction or from numerous commercial sand and gravel producers in the area.

Conclusions - Preliminary subsurface investigations indicate that conditions in the foundations and abutments are satisfactory for construction of a rolled impervious earth and rolled random rock dam. Both the spillway slopes and the base of the spillway channel will be founded in sandstone and should require no special treatment. The tunnel will be excavated from, and the outlet and intake structures founded upon, this same sandstone member with no major foundation problems anticipated. Due to the deeply weathered characteristics of the Black Hand sandstone, extensive excavation and grouting may be necessary for the development of positive cutoff. Ample random rock and impervious earth materials are potentially available within an economic range of the dam site.

12. STRUCTURAL

Structural features are shown on exhibits 15-21 and 15-22. The dam would be a two zone embankment. The upstream zone of the embankment would be composed of rolled impervious earth from borrow areas and the downstream zone would be rolled random rock from the spillway excavation. The entire upstream slope would be protected against erosion by three feet of dumped riprap, underlain by one foot of bedding material. The downstream slope would be protected against spillway tailwater erosion by an oversize rock toe. Seepage through the embankment would be intercepted by an inclined drain separating the two embankment zones. A horizontal blanket drain, extending up both abutments to five feet above spillway tailwater, would provide drainage from the inclined drain to the downstream toe of the dam. An impervious core extending to rock, in conjunction with a grout curtain would provide positive cutoff of underseepage. The dam would have a maximum height from existing stream bottom to crest, of 114 feet and a crest length of 600 feet. The crest of the dam would be at elevation 890 and would be 32 feet wide. The exterior slope of the dam would be 1 vertical to 3.5 horizontal upstream and 1 vertical to 3.0 horizontal downstream.

A spillway 100 feet wide would be excavated through a low ridge near the left abutment of the dam. The spillway would discharge into a ravine which would return the flow to Clear Creek approximately 1200 feet downstream from the dam. The spillway crest, located at

and the south meet the flora of Canada. One of the most beautiful

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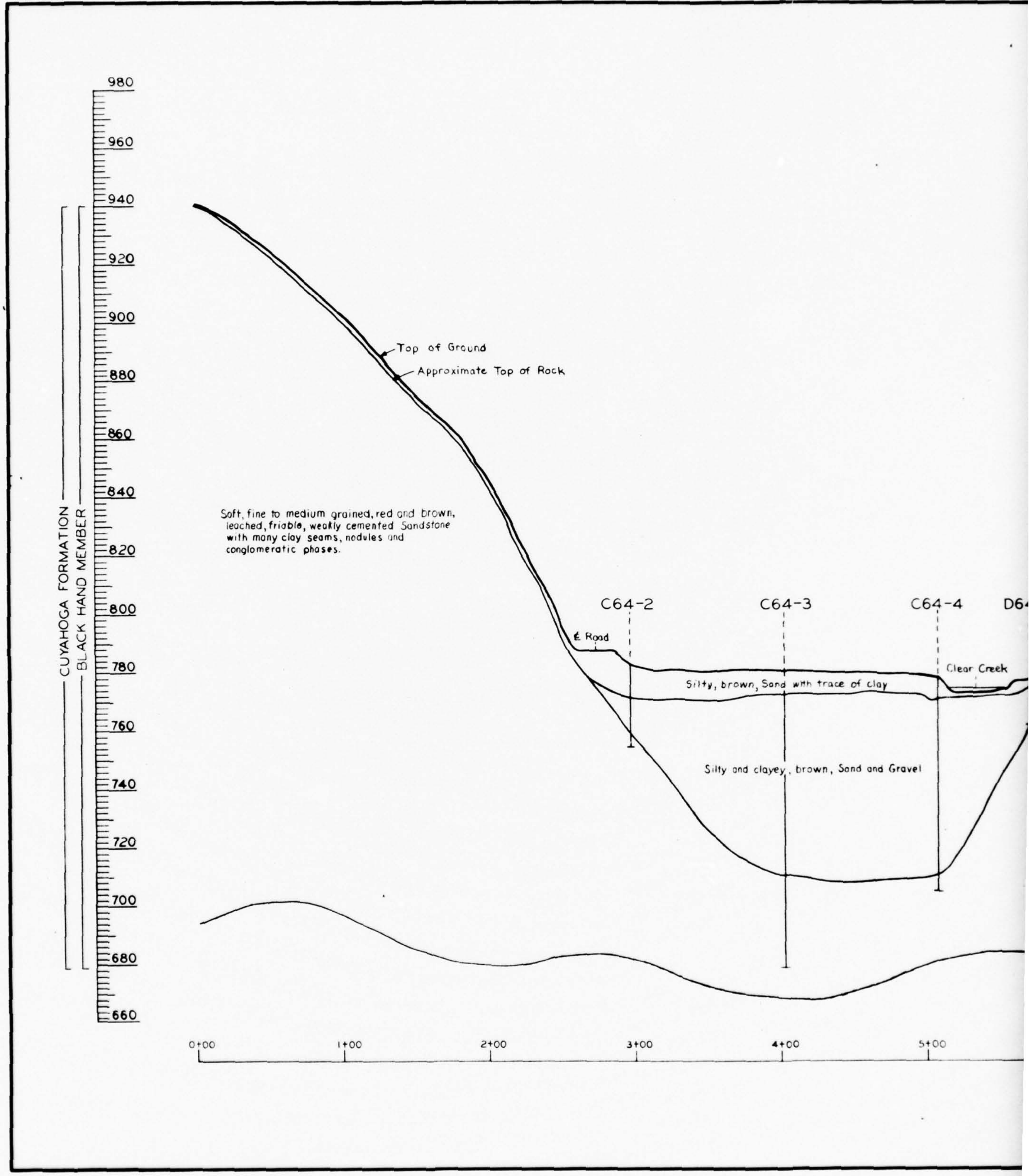

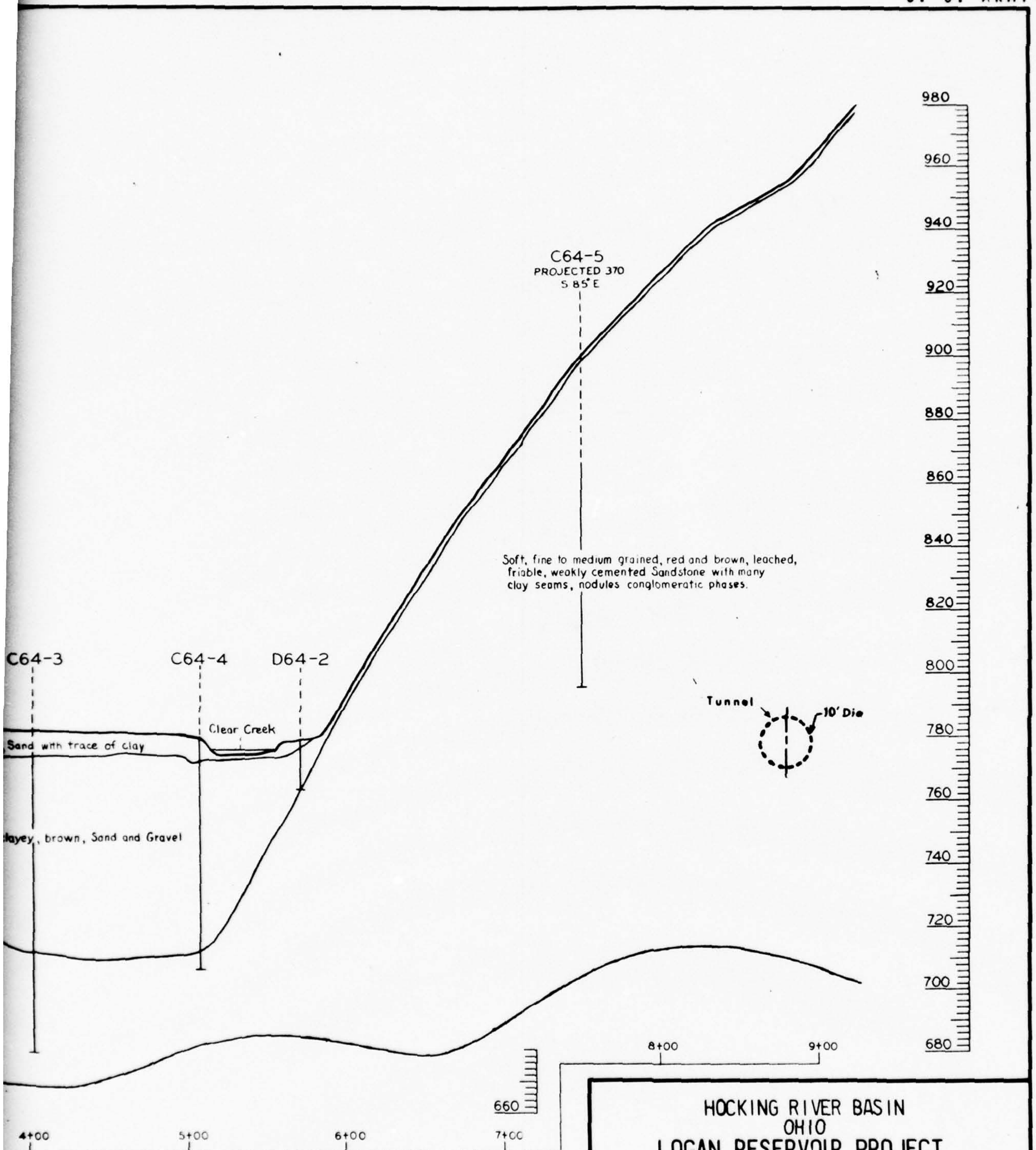

HOCKING RIVER BASIN
OHIO
LOGAN RESERVOIR PROJECT
GEOLOGIC SECTION A-A'
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
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HUNTINGTON, W. VA. JANUARY, 1965

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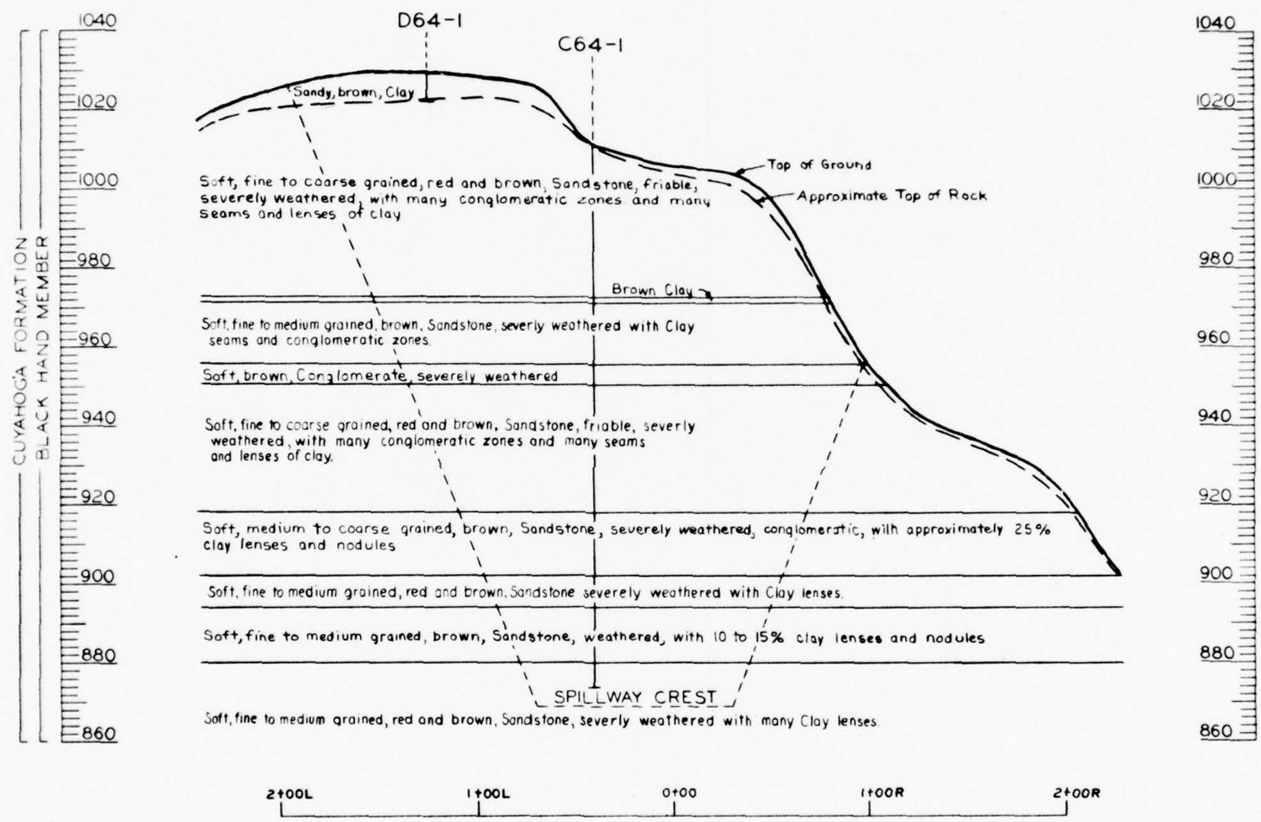

HOCKING RIVER BASIN
OHIO
LOGAN RESERVOIR PROJECT
GEOLOGIC SECTION B - B'
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON
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HUNTINGTON, W. VA. JANUARY, 1965

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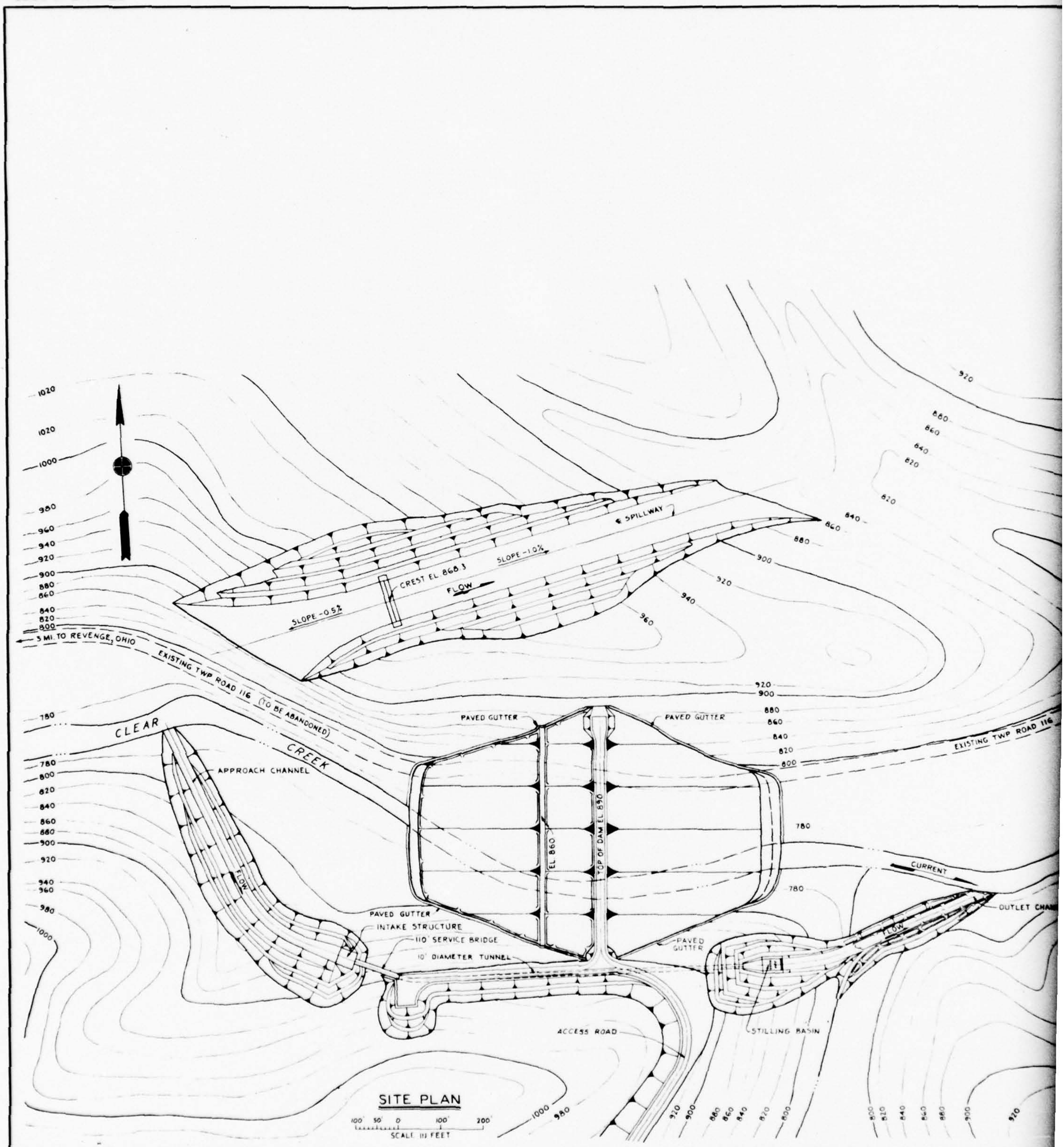

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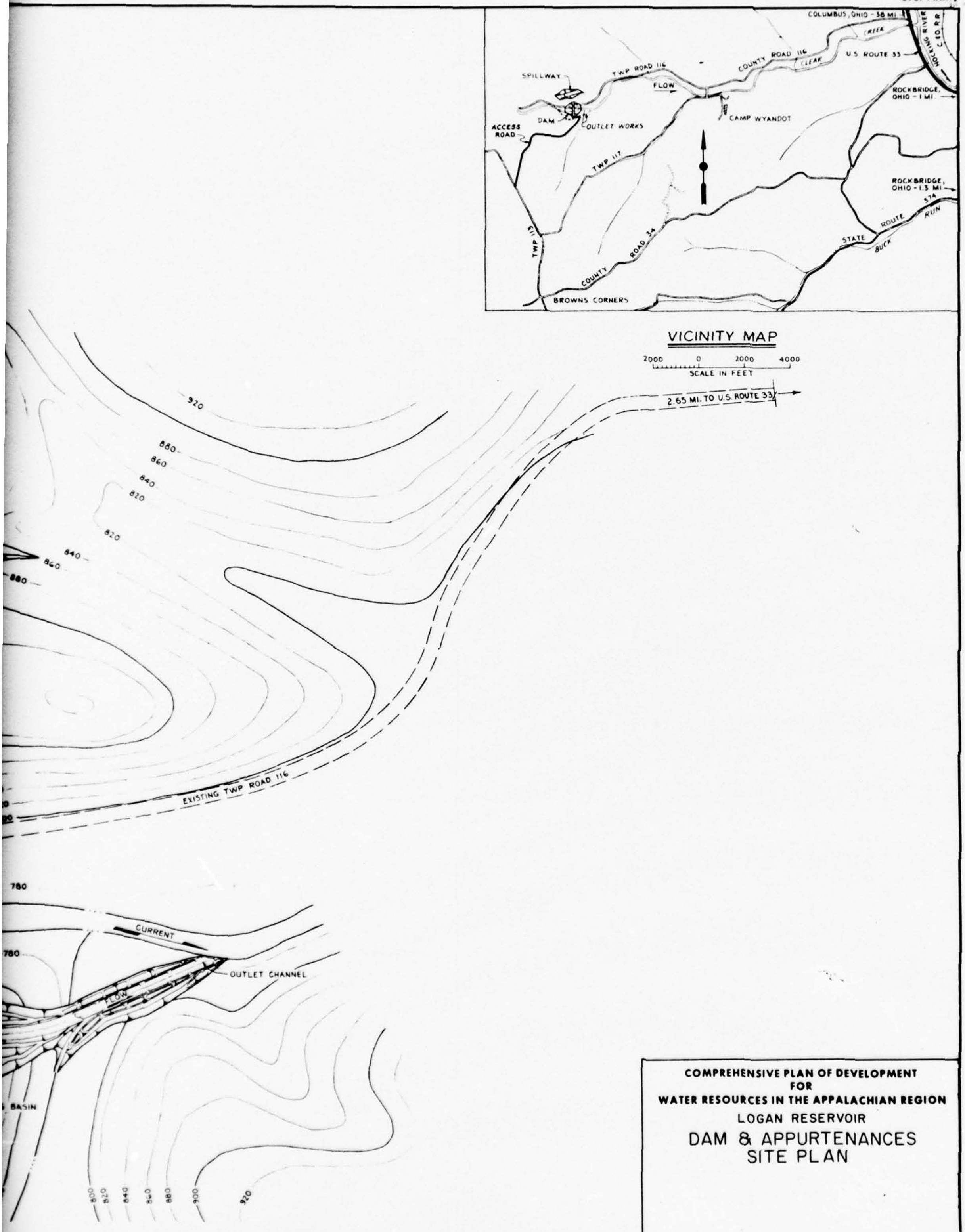

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
LOGAN RESERVOIR
DAM & APPURTENANCES
SITE PLAN

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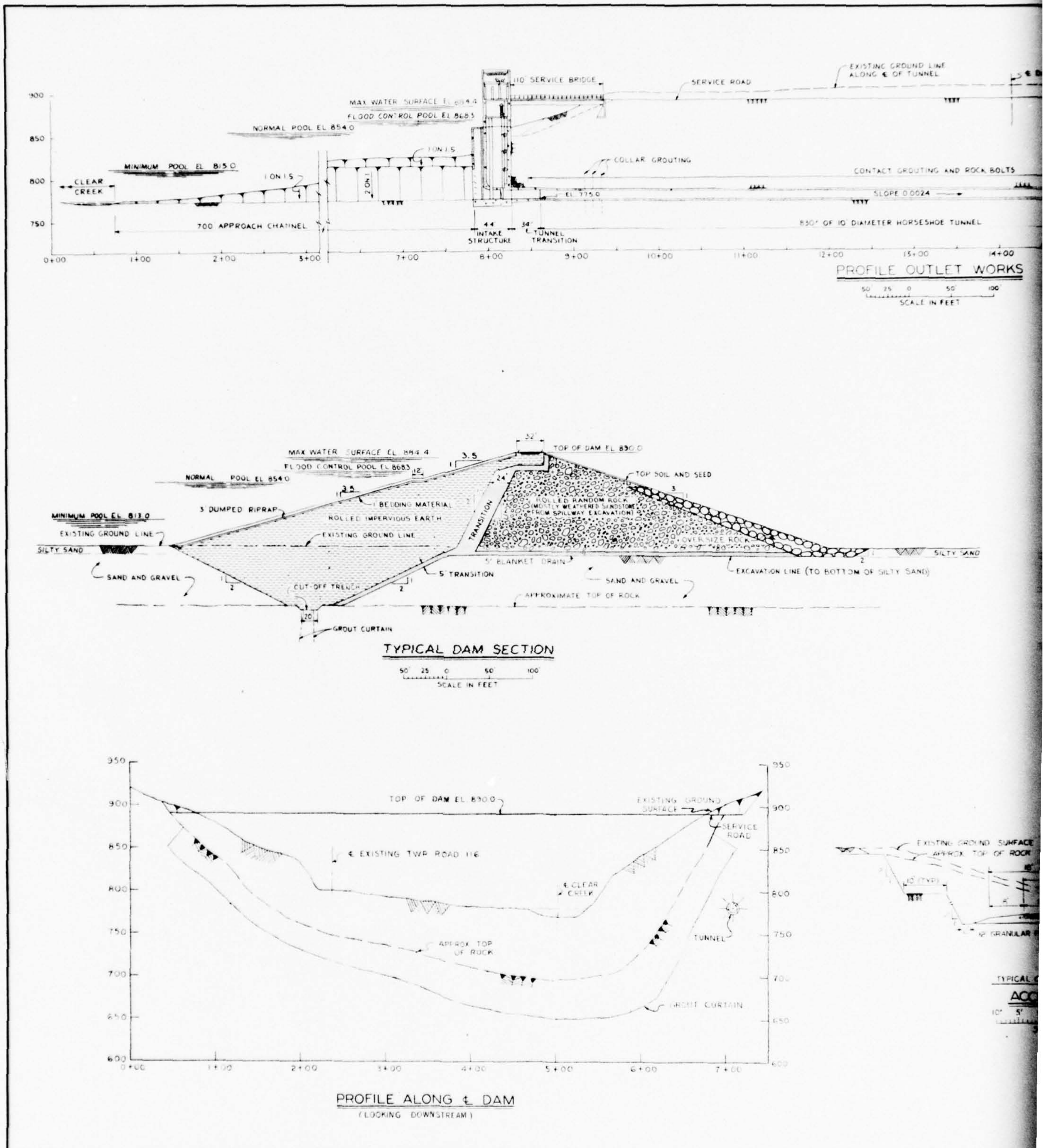
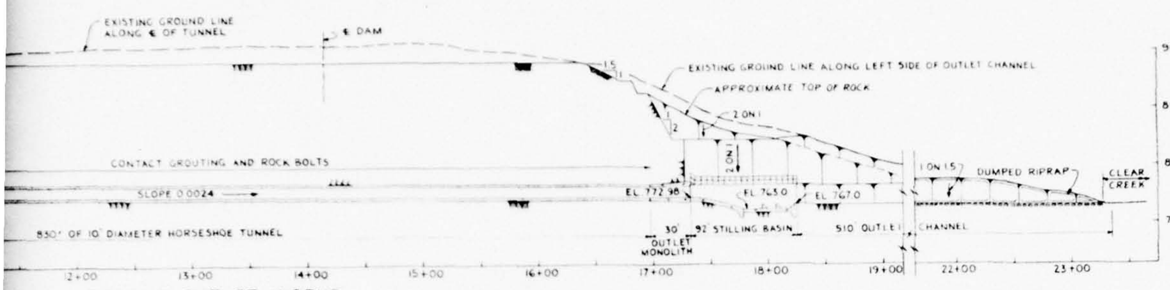
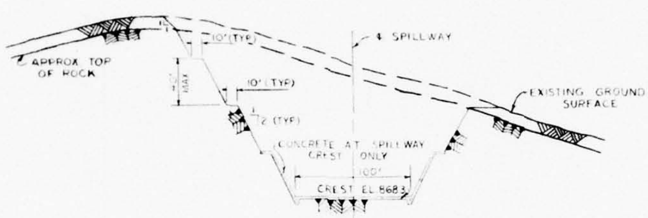




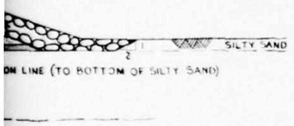
PROFILE OUTLET WORKS

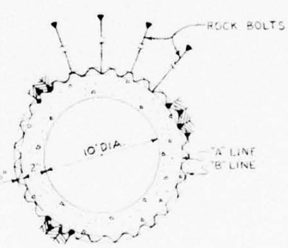
50' 25' 0 50' 100
SCALE IN FEET



SPILLWAY SECTION AT CREST

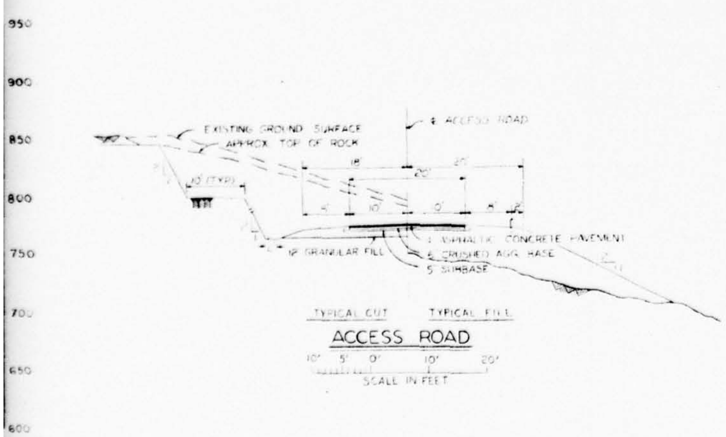
50 25' 0' 50' 100'
SCALE IN FEET





TUNNEL

5' 0' 5' 10'
SCALE IN FEET



ACCESS ROAD

10' 5' 0' 10' 20'
SCALE IN FEET

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
LOGAN RESERVOIR

DAM & APPURTENANCES
PROFILES & SECTIONS

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elevation 868.3, would be protected by a broad-crested weir. The slope adjacent to the weir would be paved to elevation 890 for protection against scour during periods of spillway discharge. Both the broad-crested weir and the liner walls would be provided with anchors and drains.

The outlet works would consist of an approach channel, intake structure (with service bridge), tunnel transition, tunnel, tunnel outlet monolith, stilling basin, and outlet channel. All of these structures, except the extremities of the channels, would be founded on rock. The approach channel would have a 30 foot bottom width and a length of approximately 700 feet, with side slope cuts of 2 vertical to 1 horizontal in rock and 1 vertical to 1.5 horizontal in overburden. It would serve to divert the flow of Clear Creek to the intake structure and tunnel until reservoir pools are developed.

The wet-well control tower would have two 5'-8" x 10'-0" sluice gates for regulation and passage of normal flows and the low flow would be controlled through a 24-inch diameter pipe. There would also be three additional multiple level intake gates for selective discharge regulation to admit water of selected temperature and oxygen content for maintenance of fish life downstream. The control tower houses a water supply system with sufficient capacity to serve two damtenders' dwellings and public use facilities located in the dam site area. Access to the control tower would be by bridge from the crest elevation of the dam.

The tunnel transition, which begins at the upstream portal, would be 34 feet in length. The two 5'-8" x 10'-0" rectangular sluices at the portal would connect to a 10 foot diameter circular tunnel at the end of the transition. The concrete lined tunnel would be a conventional type and would be 860 feet in length, including the tunnel outlet monolith.

The stilling basin would be the conventional jump type with two rows of baffle blocks and an end sill. An outlet channel, 510 feet long would return the flow from the stilling basin to Clear Creek.

13. RELOCATIONS

United States Routes 22 and 33 and Ohio Route 159 are the principal highways serving the general project area. These highways are supplemented by several county and township roads which provide access to lands adjacent to the reservoir. There is no existing railroad within the limits of the proposed Logan Reservoir.

The project would require relocation of 5 miles of County Roads 24, 26, 28 and Township Roads 262, 111 and 309. Approximately 7.90 miles of county roads and 7.33 miles of township roads would be abandoned, except where some may be left in place, subject to flooding, for access to proposed recreation areas. Relocated roads would be based on Ohio Minimum Design Standards for Rural Highways with average daily traffic volumes controlling criteria. A reservoir map showing the relocated highways is included as exhibit 15-3.

Estimates have been included for the cost of relocating County Roads 24 and 26 across the proposed reservoir. These crossings are not compatible with the Environmental Resources Development Plan and elimination of the crossings would be very desirable. The estimates were included because it is not considered appropriate to attempt to reach a negotiated agreement for abandonment of these roads at this time. It is proposed that, following modification of project authorization by the Congress and subsequent detailed site selection studies, the Chief of Engineers be authorized to participate in the construction or reconstruction of transportation and utility facilities in advance of project construction, as required, to avoid increased costs for relocations. Adoption of this proposal would permit negotiations between the Ohio Departments of Natural Resources and Highways, County Officials and the Corps of Engineers concerning plans for highway relocations soon after Congressional approval. If negotiations result in agreement for abandonment of highways crossing the reservoir, funds included for these relocations then could be used to improve alternate routes and/or periphery roads.

Various utility lines would be affected requiring the relocation or abandonment of high pressure gas transmission lines and medium pressure gas distribution pipe lines. Relocation and removal of medium voltage distribution power lines and miscellaneous local and long distance telephone lines also would be required. Following is a more detailed discussion of the affected facilities.

In the project area, the Ohio Fuel Gas Company owns and operates the transmission and distribution pipe lines of 8 inches and 10 inches in diameter. The proposed adjustment of the 10-inch line includes providing manifolds across the reservoir and weighting of both the existing and the manifold line. The 8-inch line would be abandoned since it serves only one residence and a new 2-inch line would be provided above pool to provide that service.

The power facilities affected by the proposed project are owned and operated by Ohio Power Company and South Central Electric Cooperative, Incorporated. These facilities consist of one 4-wire, 3 phase and several 2-wire, single phase distribution lines. Approximately 15.5 miles of distribution line would be removed and replaced with 5.8 miles of new lines.

Approximately 9.59 miles of telephone lines and cables would require removal and 12.14 miles of new lines constructed. These facilities are owned and operated by the Ohio Bell Telephone Company and the General Telephone Company of Ohio.

Where it is necessary to make relocations of gas, electric or telephone lines through the Clear Creek Nature Area or recreation areas, consideration will be given to make these installations underground in order to preclude environmental intrusions. All relocations will be coordinated with the agencies responsible for administering the recreation potential of the projec

There are two cemeteries located in the proposed project area. The Hopewell Cemetery, containing approximately 160 graves, is located on Fairfield County Road No. 69, near its junction with Fairfield County Road No. 28. The Clearport Cemetery, containing approximately 600 graves, is located on Fairfield County Road No. 24, near its junction with Fairfield County Road No. 69. The cemeteries are above the maximum flood control pool elevation 868.3, but are located within the proposed Government taking line. It is considered necessary to relocate the cemeteries to suitable reinterment sites outside the project boundaries to avoid conflicts of usage and inconvenience to cemetery interests.

14. REAL ESTATE

The proposed reservoir would extend approximately 11 miles upstream along Clear Creek and lies in the northwesterly portion of Hocking County and in the southwesterly portion of Fairfield County.

The extent of land acquisition and real estate interests to be acquired would essentially conform to the amended "Joint Policies of the Department of the Interior and the Army Relative to Reservoir Project Lands." The fee taking would be established by applying the criteria for acquisition to a minimum distance of 300 feet landward of the full flood control pool stage or to a vertical guide taking line five feet above that pool stage, whichever is greater. Fee title would be taken to the reservoir lands, nature area lands, dam site, or construction areas, along with the entireties of properties which would be unduly severed or left without reasonable access. Exceptions to this general policy would be in remote areas of the project where, due to infrequent flooding, it is considered to be in the best interest of the Government to acquire flowage easements. Lands to be acquired for the nature area and specifically for recreation development purposes would lie outside the minimum taking limits as determined by the general policy. The final limits of land required for these special purposes will be determined by studies to be made subsequent to authorization of the purposes. All mineral rights would be acquired except oil and gas which would be subordinated to project purposes. Preliminary estimates of the tentative taking include about 8,750 acres of joint use lands, 3,100 acres specifically for general recreation development and 3,800 acres for the nature area. These approximate areas and the project limits and outlines indicated on exhibit 15-23 will be subject to revision in detailed post-authorization studies.

The project area is divided into two distinctly different categories. The upper part of the project lies in a glaciated area which is characterized by low gently sloping hills and broad flat valleys. The lower portion of the project lies on the well defined margin of the glaciated area and in an area that has not been affected by direct glaciation. This lower portion of the project contains a conspicuously narrow main stream valley bordered by rugged slopes which form the adjacent irregularly shaped ridges.

The terrain has notably governed the development in the project area. The flat lands in the upper portion of the project are divided into farm units. There is a small farm community known as Clearport, located in the center of the project area. Clearport centers around a general store, two churches, a community building, an unusually large junk yard, and about ten residential properties. The only other urban area in the vicinity of the project is the town of Amanda located outside the project limits at the upper reaches of the pool. The economy of the project area is dependent on agriculture. The lower portion of the project area is not suitable for farming due to the rugged terrain. This area is, however, highly developed in that the timber and natural beauty have been preserved and cultivated.

The Camp Fire Girls, Inc. currently have holdings of about 500 acres which is located within the area of the proposed Nature Area in Clear Creek Valley. It is proposed that the Camp Fire Girls land holdings be exempted from acquisition subject to provisions that: (1) In the event the area were no longer used for its present purpose, the land would be conveyed to the Federal Government; (2) the Federal Government be permitted to develop nature trails or other facilities on lands owned by Camp Fire Girls, Inc., in a manner that would be compatible with operation of the camp; and (3) the Federal Government be granted the right to review and approve plans for future improvements on lands owned by Camp Fire Girls, Inc.

Real estate costs were based on a gross appraisal prepared during preliminary planning stages. Additional lands subsequently incorporated for recreation and nature area purposes were not appraised. Costs for acquiring these added lands were estimated by applying unit costs for similar types of land and improvements in the appraised area to corresponding units in unappraised areas. A contingency factor of 25 percent was added to the costs thus estimated.

15. ENVIRONMENTAL RESOURCES DEVELOPMENT - THE CONCEPT EVOLUTION

The evolution of a comprehensive plan for the development of environmental resources brought about substantive questions bearing upon formulation of an optimum water resource and related development plan. In that respect, those considerations bearing upon formulation have been previously discussed, and principally included the overall shaping of a plan which would best provide for preserving and enhancing the valuable natural environment of Clear Creek within the framework of the multiple objectives of resources planning. The formulation process required an analysis of the evolution of plans for the Clear Creek Nature Area.

Formulation of an outdoor recreation plan involved monetary analysis based on objectives developed independently. The resulting outdoor recreation plan brings together the views of the Ohio Department of

Natural Resources; the Bureaus of Outdoor Recreation and Sport Fisheries and Wildlife of the U. S. Department of the Interior; and the Corps of Engineers. Adjustments have of necessity been made in the general recommendations of each participant in order to accommodate a resource plan of widest human benefit.

It particularly should be noted that the character of the plans presented herein departs from the access-oriented concepts that have in the past accompanied such water resource development proposals. In response to Public Law 89-72, these plans were formulated with a view to meeting modern state park standards and administrative criteria of the principal participant in the financial, and operation and maintenance obligations of the plan. Consequently, costs are substantially higher and the quality of opportunity substantially enhanced over that afforded under previous authorities and concepts.

Environmental influences. The Logan Reservoir Project would be located on the northern edge of the "Hocking Hills" region of southeastern Ohio. The Hocking Hills are an unglaciated section located in southern Fairfield and Western Hocking Counties. The reservoir would be on Clear Creek in both Hocking and Fairfield Counties, 8 miles south of Lancaster and 30 miles southeast of Columbus. Clear Creek has its origin in Fairfield County and flows eastward across the Allegheny plateau to the Hocking River. The Clear Creek drainage area is divided into two physiographic types. The upper portion is glaciated, and the land is composed of rolling hills and wide, flat valleys. Most of this land has been cleared for agriculture. Downstream, in the unglaciated portion, the topography is rugged and is characterized by steep slopes, narrow valleys, high sandstone cliffs, and deep, wooded ravines.

Two streams occupied what is now the valley of Clear Creek before the glaciers of the Ice Age altered the topography. One stream flowed east and one flowed west from a divide which was then located upstream of the selected dam site. The east-flowing stream terminated in the northward-flowing Lancaster River (now the Hocking River). The advancing glaciers covered the northern and western portions of the State of Ohio, but stopped just west of the dam site, leaving the southeastern part of Ohio unglaciated. Although southeastern Ohio was not glaciated, the Ice Sheets did effect tremendous changes in the topography. The westward-flowing section of Clear Creek was dammed by ice and glacial drift until the water backed up and formed a lake. It is probable that the melting glaciers enlarged the lake, forcing the water to seek a natural outlet through the divide, which resulted in the carving of a deep gorge and ultimately the reversal of Clear Creek. The overall effect of this torrent was not only the carving out of the gorge, but also the deposition of limestone sediments along the valley walls on the largely acid sandstones of the Allegheny plateau. The places where these alkaline sediments were dropped can be determined today by the presence of such lime-loving trees as the Redbud, the Kentucky Coffeetree, and the Yellow Oak.

The Clear Creek area has been studied through the years not only by geologists, but by botanists and zoologists as well. The life histories of many animals have been compiled, new species have been discovered, ranges of known species have been extended, and many years of study have been spent in this valley. The first Ohio specimen of the Allegheny Woodrat (Neotoma pennsylvanica) was collected on Clear Creek, hence the name Neotoma for the present outdoor research laboratory. The Clear Creek area is the northwestern limit of the range of the Allegheny Woodrat. New species of other animals also have been collected from this area. In 1928, the first specimen of Say's Bat was captured here; likewise, the first Upland Choras Frog collected in Ohio was found. The first life history study of the Black Vulture which was undertaken in this region, revealed that this bird nests in the Clear Creek area, with only one other known nesting site farther north.

The unusual topography of the Hocking Hills region of Ohio has enabled various types of animals to live in the region, and many live in the unique swamps and bogs (rare in unglaciated areas) which were formed as glacial till filled in poorly drained glacial valleys. The bogs enable many species of Canadian fauna to live in more southern latitudes, such as the Northern Water-Thrush, the Rose-Breasted Grosbeak, the Swamp Sparrow, the Red-Backed Vole, and the Woodland Jumping Mouse. The filled valleys also serve as invasion routes for some of the western species of animals which probably would not otherwise have established themselves so far eastward. The Clear Creek gorge also contains the more common animals of this latitude, such as deer, raccoon, squirrel, grouse, and woodcock.

Many botanists have studied the region of Hocking Hills, from Bigelow in 1841, to those presently conducting studies in this area. The Clear Creek area is a delight to botanists because of the variety of plants that are able to live in the many diverse habitats and microclimates of the region. The diversification of this area is exemplified by the 1,267 plant species found here. The distinct microclimates found in ravines along Clear Creek gorge harbor relict species which would not otherwise survive away from their natural ranges. An example is Sullivantia, a plant which grows only on cliff faces having abundant moisture, good aeration, and adequate light. This plant is known only from seven Ohio counties, three counties in Indiana, and one in Kentucky. Another plant which requires a similar habitat is the Round-leaf Catchfly, found locally throughout the southern Appalachians, but occurring in only four counties of Ohio. A fern, the Gray Polypody, reaches its northern limit in the valley of Clear Creek. Another fern found at Clear Creek is the Ostrich Fern, which occurs in Ohio only in the Lake Erie region and in Hocking County.

The Clear Creek gorge area affords a natural overlapping of certain plants, and in its ravines, mountain plants of the Appalachian

and the south meet the flora of Canada. One of the most beautiful of the Southern Appalachian flora is the Great Rhododendron, a plant which reaches its best development on densely shaded slopes and in dark ravines, such as those offered in the microclimates of Clear Creek. The Great Rhododendron is distributed throughout the Appalachian mountains from New England to Alabama, but is very restricted beyond that area.

The northern latitudes are represented in the Clear Creek area by such flora as the Hemlock tree, a large evergreen native to Canada. The Hemlock is a slow growing tree, especially suited to rocky habitats and dark, moist ravines where its roots can obtain a constant supply of surface water. It is frequently found with the Shining Clubmoss, a fern relative also of the Canadian area, which reaches its southern limits in Ohio.

The northern flora, as well as the Appalachian flora, overlap with such southern species as the Angelica Tree, which occurs in eight Ohio counties. The Clear Creek valley is also the farthest range to the northwest of the Creeping Phlox, a small purple flower which occurs in Ohio only in Jackson and Hocking counties.

Trillium Hollow, previously unnamed, is a small gorge that deserves mention for its outstanding natural significance. It is the second hollow on the right descending bank, 1,200 feet upstream from Revenge. The hollow, relatively unknown because of its hidden entrance, is of interest to botanist and geologists alike. The great variety of flora in the hollow is dominated by huge plots of giant snow trillium and also purpose trillium.[1/] The beds of trillium which occur on the steep sloped sides are one of the larger collections to be found in southeastern Ohio.

Although there are many interesting geologic formations in the project area, Trillium Hollow is of particular significance because of the tremendous overhanging cliffs that have been created by thousands of years of erosion. The cliffs in many places exceed 25 feet in height and have overhang of almost the same amount.

The main portion of the hollow formed by the previously unnamed tributary is approximately 1,300 feet in length, 65 feet deep and averages about 50 feet wide. Development of the hollow would be impractical and intensive use would be detrimental to the area. Its best use would be as a restricted outdoor laboratory, accessible from the camping area.

The flood control pool of the dam at mile 3.1 would inundate approximately two-thirds of the length of Trillium Hollow, however, the periodical flooding would cover only a portion of the plant life and

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1/ Standardized plant names by Kelsey and Dayton, 1942.

therefore would have only minor detrimental effects, if any, on the ecology. The seasonal pool would affect only the lower portion of the hollow, approximately 100 feet above the mouth. The dam site at mile 5.6 on the other hand would cause a somewhat greater portion of Trillium Hollow to be covered by both seasonal and flood control pools.

Recreation Area of Analysis - The physical zone of municipal general outdoor recreation influence as defined by the Bureau of Outdoor Recreation in Appendix F comprises eleven counties in Ohio with a combined 1960 population of 1.1 million people, about 81 percent of which resided outside Appalachia. The Bureau of Outdoor Recreation estimates that this population will reach 2 million in 1975 and over 3.3 million by the year 2000. A majority of this population would continue to reside outside Appalachia.

Determination of demand - The demand for water-oriented recreation generated within the eleven county area of influence by 1980 has been estimated at 37,002,000 activity days. The BOR projects this demand to increase to 66,404,000 activity-days by the year 2000, and to 95,716,000 by 2020. (See Recreation and Aesthetics, Appendix F). The bureau indicates that the present demands exceed the total supply by nearly nine-fold and that the demand is anticipated to multiply by a factor of six by 2020. Therefore, to meet the total demand in 2020, (for the four selected activities utilized in BOR's analysis) the current supply of water-based activity opportunities would have to multiply by a factor of over 50.

The critical need for expanded outdoor recreation opportunities within this area of Ohio is abundantly apparent. The Ohio Department of Natural Resources has become increasingly aware of the demand for higher quality recreation experience opportunities. The demand for higher quality as well as diversity of opportunity is compounding the simple quantitative demands.

Detailed analysis of the outdoor recreation mix of activities, while recognized as a critical element in recreation planning, is reserved for stages of detailed project site planning, should project feasibility and authorization be established.

Capacity of proposed recreation development - Using a design load of ten people per acre of developed recreation lands, the project has the capacity to provide 2,652,000 visitor days annually. In addition, approximately 40,000 fisherman days, 4,500 hunter days and 120,000 visitor days for the Nature Area, could be expected annually. Visitation of the estimated magnitude would reflect the potential of the project with an intensive development program oriented to high quality day use, vacation and week-end use.

The state park outdoor recreation plan - The plan of development for recreation was jointly planned by the Ohio Department of Natural Resources and the Corps of Engineers, and was coordinated with the

Bureaus of Outdoor Recreation and the Sport Fisheries and Wildlife of the U. S. Department of Interior. The Department of Natural Resources and the Corps integrated the recreation planning with the plans for the Clear Creek Nature Area which are presented subsequently. The integrated environmental resources development plan is shown on exhibit 15-23 (page III-15-115).

The overall Clear Creek State Park development plan contemplates a complete recreational complex with an efficient layout of activity areas using the reservoir embayments as "separation buffers." The distribution of wooded ravines, and the embayments they form, create peninsular areas of optimum size and conformation for high-density use without interference with one another. Even the main east-west stem of the reservoir would be used in this manner, separating day use on the north shore, from overnight use on the south shore.

North shore recreation area - This 4,142 acre area would include all the project lands on the north side of the reservoir, exclusive of a small operations area at the dam site. Past the entrance gate, the interior access road would open into a vista of the valley and Logan Reservoir. The road then would move closely along the north shore for about one mile using an existing highway. The beach location would permit heavy peakload traffic to the swimming beach to be shunted off the main access road first, which would eliminate much of the traffic congestion which normally develops in day-use areas with larger beaches (planned beach parking capacity is over 865 cars). The boat launching and docking area, with capacities of 365 cars with trailers and 100 cars, would be located adjacent to a large embayment providing good physical separation from the beach and a protected basin for boat moorage, sailboats, and hand-propelled water craft. Picnicking activities would occupy two major peninsulas and would contain 1144 units.

South shore recreation area - This wooded area features tent and trailer camping, group camping, cabins, and a dining lodge with interpretative center. A small beach, and boat ramp with docking facilities, would serve the entire overnight area. Since these facilities would be located directly across the reservoir from the major boating concession, the latter facilities would adequately serve boating needs for both overnight and day-use activities. Camp and cabins control entry stations would limit access into the family tent and trailer camping area and the vacation cabin area (over 800 family units in all) which occupy separate peninsular areas. A similar type of separation would be provided for the group camp area, and for the dining lodge and interpretive center, each of which would occupy contiguous peninsular areas leading to the nature area. A separate access from outside the project boundary would be provided to this latter facility, as would a spur from the camping area, but the two roads would not be connected.

Trails - A trail system approximately eight miles in length will be developed within the recreation complex. Consideration will also be given to the development of an integral network of trails connecting

the reservoir area to the Hocking Hills Region and the Buckeye Trail. The Buckeye Trail, a statewide trail connecting Cincinnati and Cleveland, passes within about four miles of the control point of Neotoma Valley. A connecting trail to this development would broaden the scope of the Logan Reservoir Project. It would tie the project to the Wayne National Forest on the east, the Hocking State Forest and Tar Hollow State Forest to the south and Burr Oak State Park to the east.

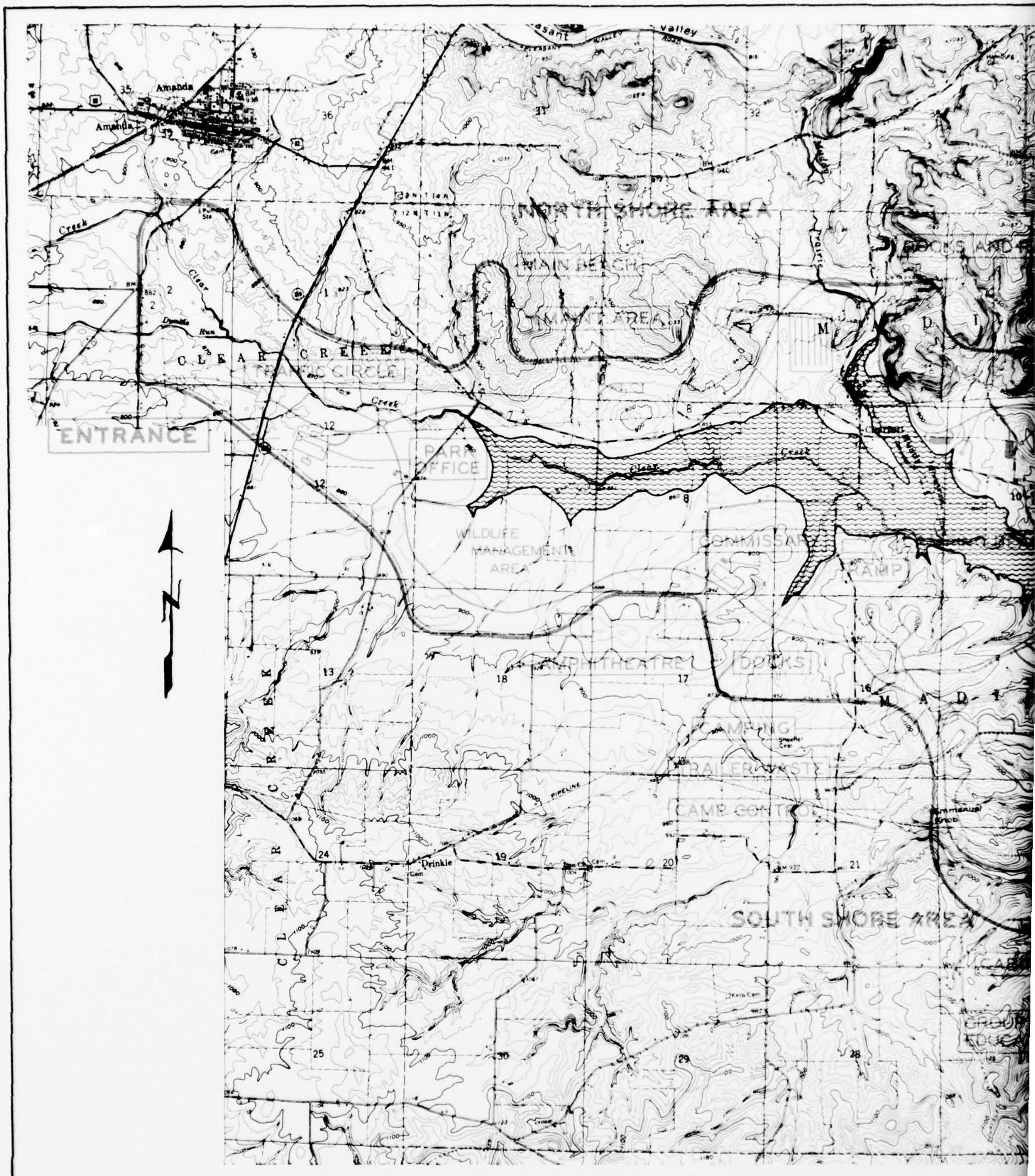
A two mile trail to the south would connect the Neotoma Valley to Cantwell Cliffs Recreation Area, the nearest Hocking Hills Park. The most distant, Ash Cave, is less than fifteen miles away. A trail of about six miles in length to the west would connect the project area to the A. W. Marion State Park.

The proposed project should be closely related to the Hocking Hills Region in every way possible, through trails, road access, public information, directional signs, etc.

Fish and wildlife management - Hunting opportunity is generally excellent within a 25-mile radius of the reservoir. Over 113,000 acres of land and water in public ownership are presently available for hunting at 16 separate areas. Five of them are actively managed for wildlife. Although 2,600 acres are specifically designated for intensive wildlife management at Logan Reservoir, other portions of the project area would still be available for public hunting without conflict with other uses. Except for the squirrel season which generally opens shortly after Labor Day, hunting seasons for upland game usually begin well into November, when most general recreation is at a minimum. Also, the season for vacation cabins can be extended to accommodate hunters, providing complementary benefits from general recreation facilities.

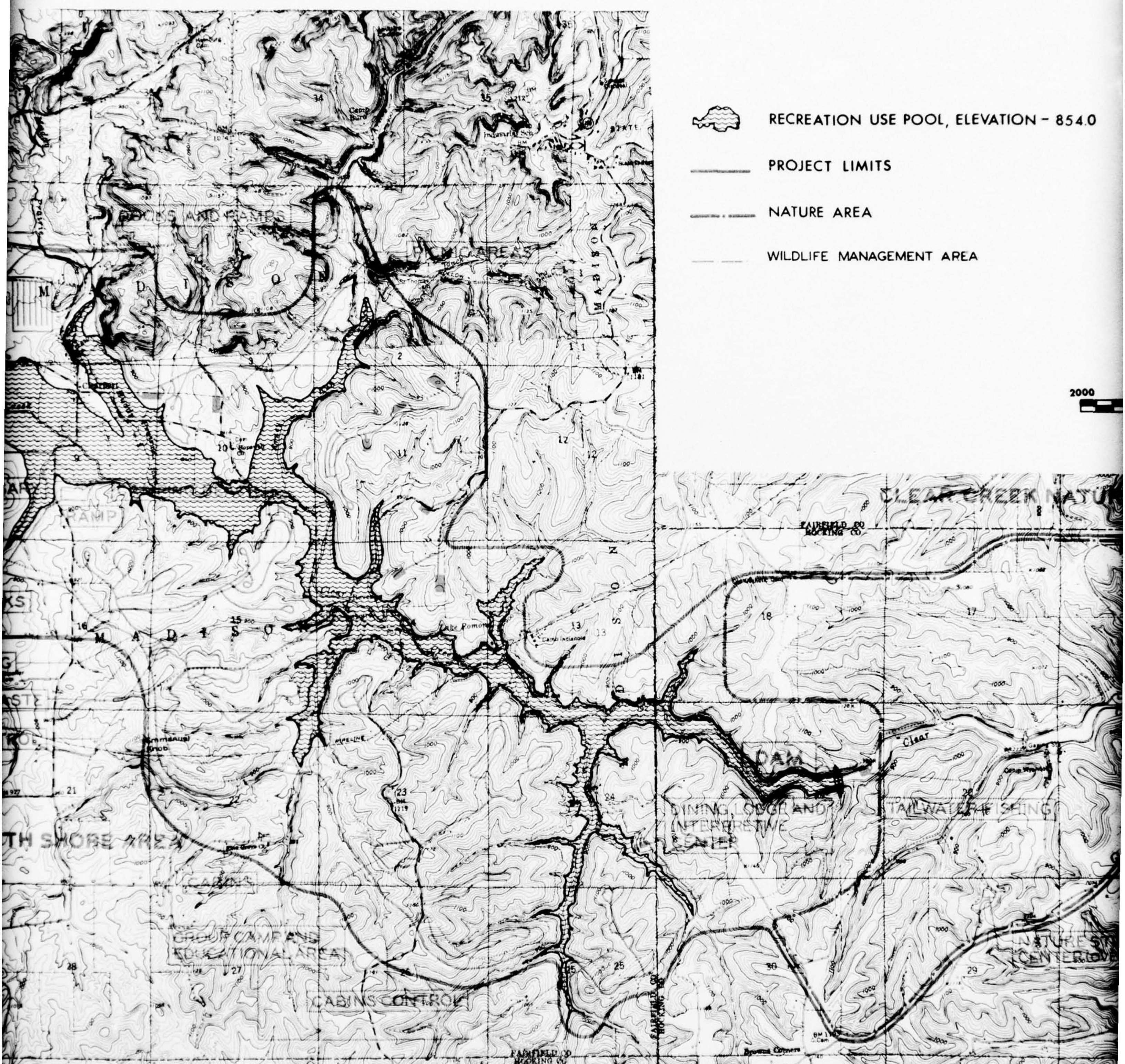
In addition to fishing opportunity in the reservoir project, two tailwater fishing access areas are to be provided to assure full utilization of the downstream fishery.

Clear Creek Nature Area - The plan for preservation and enhancement of the aesthetic and ecologic environment of the Clear Creek Valley, as jointly developed by the Corps of Engineers and the Ohio Department of Natural Resources, will include most of the land below the dam from ridge to ridge, to a point at which Clear Creek crosses U. S. Route 33. The 3,800 - acre area will have a Resident Outdoor Education Center, a Nature Interpretive Center, approximately 10 miles of hiking and nature trails, and the Neotoma Ecological Research Area. The plan would positively insure permanent preservation of three miles of the Clear Creek valley, including the Neotoma Valley, and would permit intelligently controlled public usage. The Nature Area would be the allied interpretive facility of Clear Creek State Park on Logan Reservoir. With the cabins, camp grounds, and the day use facilities of the state park nearby, the



NORTH SHORE AREA
MAIN BEACH
ENTRANCE
PARK OFFICE
WILDLIFE MANAGEMENT AREA
CLEAR CREEK
TRAFFIC CIRCLE
RAMP
DOCKS
CAMPING
SOUTH SHORE AREA
Amanda
Drinkle
PIPELINE
Clear
Creek

2'


RECREATION USE POOL, ELEVATION - 854.0
PROJECT LIMITS
NATURE AREA
WILDLIFE MANAGEMENT AREA
2000
DOCKS AND RAMPS
PICNIC AREAS
CAMP
CLEAR CREEK NATU
FAIRFIELD CO
HOCKING CO
Lake Pomona
TH SHORE AREA
CABINS
GROUP CAMP AND
EDUCATIONAL AREA
CABINS CONTROL
DAM
DINING LODGE AND
INTERPRETIVE
CENTER
TAILWATER FISHING
NATURE ST
CENTER
Clear
PIPELINE
Browns Corners

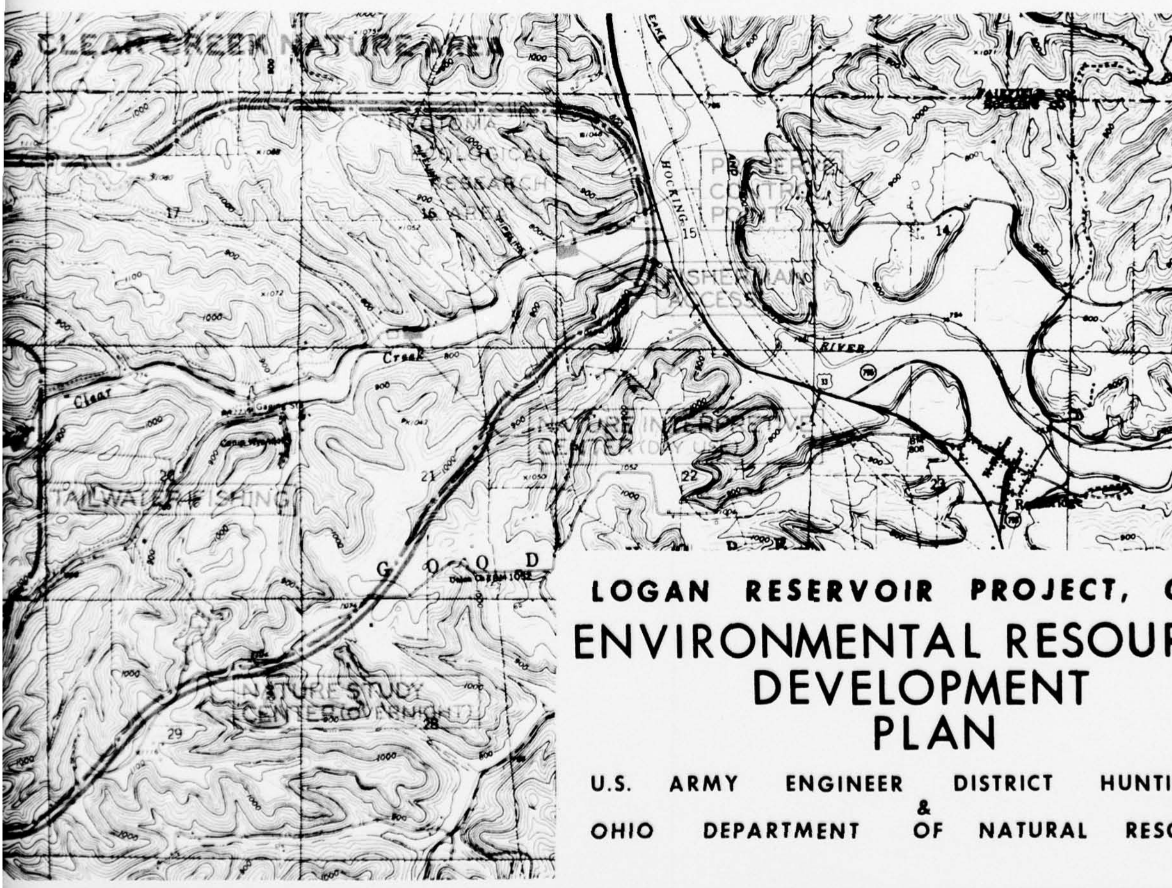
3

LEGEND

USE POOL, ELEVATION – 854.0	INTERNAL ROAD NET, PARKING AND OTHER FACILITIES
MITS	NATURE TRAILS
A	ECOLOGICAL PRESERVE
NAGEMENT AREA	

2000 0 2000 4000

SCALE IN FEET



LOGAN RESERVOIR PROJECT, OHIO

ENVIRONMENTAL RESOURCES DEVELOPMENT PLAN

U.S. ARMY ENGINEER DISTRICT HUNTINGTON
&
OHIO DEPARTMENT OF NATURAL RESOURCES

EXHIBIT 15-23

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value of the preserve would far exceed that if it were not associated with such facilities. The Nature Interpretive Center would be unique to the Central Ohio area as no other nature center of this type presently exists in this part of the state.

Access to the Nature Area would be controlled with a check station or control point located just west of U. S. Route 33 on the present road through the valley. It is proposed to provide a caretaker's residence at that location.

The Neotoma Ecological Research Area would continue to be utilized for microclimatological research under the direction of the Ohio State University. In this way, the long-standing and accumulating research at Neotoma can continue without hindrance.

The staff to operate and maintain the facilities would include a director, assistant director, three teacher-naturalists, a cook, assistant cook, caretaker and secretary. The director would be responsible for planning, scheduling, and providing the leadership for the program and facilities of the entire Nature Area. The assistant director would serve as an administrative assistant to the director as well as direct the resident Outdoor Education Center and its program. The teacher-naturalists would handle the actual program and display responsibilities of the nature interpretive center.

A staff of this size could not only handle the anticipated visitation to the area but could maintain the quality of interpretive and outdoor education programs desired in the area.

Several houses located on the area could be utilized as housing for the professional staff of the area.

The Nature Interpretive Center would be designed as a day use facility that would house the natural history displays, a visitor information desk, movie theater, administrative office and workroom. This center would offer programs dealing with the natural and human history of the Clear Creek Valley and Hocking Hills region. Guided tours by teacher-naturalists during the year would be offered by the center with special emphasis on school group tours.

The Nature Center would be the central facility of the area and thus would be the focal point for the visitor to the area. Ten miles of hiking trails through the unique habitats of the area would begin and end at the center and add highly to its value.

The nature center would be so designed that persons visiting the center could easily become oriented to the valley's unique flora and fauna by way of a film or slide program in the theater and learn of its significance through the interpretive displays in the exhibit area.

The greatest assets to the nature center would be, without a doubt, the nature trails which originate from the center. The trails would offer outstanding hiking opportunities in the Central Ohio area and also would make available an exquisite resource area for the study of natural history by schools, nature clubs, and nature enthusiasts.

Of significance would be the development of a self-guided trail and a braille trail along loop trail A. Both would interpret the natural history of the area along the trail without the aid of a guide by means of interpretive signs of a descriptive brochure available at the trail entrance. The Braille Trail would require special construction, signing, and interpretive techniques and would provide an effective tool in helping the blind learn about nature and the out-of-doors.

The rest stop would be located approximately halfway around the trail system and would offer the hiker a place to relax and eat a picnic lunch. The rest stop would consist of a small cleared area, a shelter of the "Adirondack" design with picnic tables and fire rings for meal preparation. The area and shelter would not be intended to be used as an overnight camp and would be maintained as a day use facility only.

The outdoor education center would be designed for statewide use by school groups, conservation clubs, and outdoor oriented organizations as a resident overnight facility. This center would offer programs designed to stimulate the interest and understanding of students through classes and field projects under the direction of their teachers and resource persons from the Department of Natural Resources.

The basic facility would consist of meeting rooms, dormitories, dining facilities, a library and exhibit area. The center is slightly removed from public day use facilities of the nature preserve, yet it will be an integral part of the total naturalist program. The nature interpretive center would, with its trails and interpretive displays, add much to the total resources of the resident outdoor education center.

The need for such a facility in the Central Ohio area is apparent. At the present, no such facility exists within an easy drive of Columbus. Schools presently involved in outdoor education programs are travelling as much as 70 miles to the nearest facility that can offer resident, winterized accommodations. Some school systems are not involved in resident outdoor experiences for students due to the lack of good facilities nearby.

It is anticipated that the facility would operate at maximum level for approximately 30 weeks during the school year and would involve 1,440 children for 7,200 camper days and 120 teachers for 600 camper days.

This, however, would depend upon the school calendar, length of the resident experience for each group, and size of groups that are accommodated. The Center could be utilized on weekends during the school year and weekly during the non-school season by groups and organizations desiring this type of facility. Total maximum use for the duration of non-school season and weekends could reach 3,000 persons with 9,000 camper days.

The essential components of both the recreation development and the nature preserve were incorporated into an overall environmental resources plan. This plan is shown on exhibit 15-23.

The facilities were designed to fit the scale and purpose of the nature preserve. These facilities are described in more detail as follows:

NATURE INTERPRETIVE CENTER

(day-use facility)

Center to include reception and display area, information counter, 90 seat capacity theater, projection booth, administrative office, workroom-storage area, rest rooms, and basement. 60 parking spaces to serve center and hiking trails. Plan based on typical design similar to that shown on exhibit 15-24.

Space Criteria:

Reception and display areas	2,550 sq. ft.
Theater	1,516 sq. ft.
Administrative office	288 sq. ft.
Workroom - storage area	360 sq. ft.
Rest rooms	352 sq. ft.
Basement	925 sq. ft.
Total Area of Center	5,991 sq. ft.
Total area of parking	18,000 sq. ft.

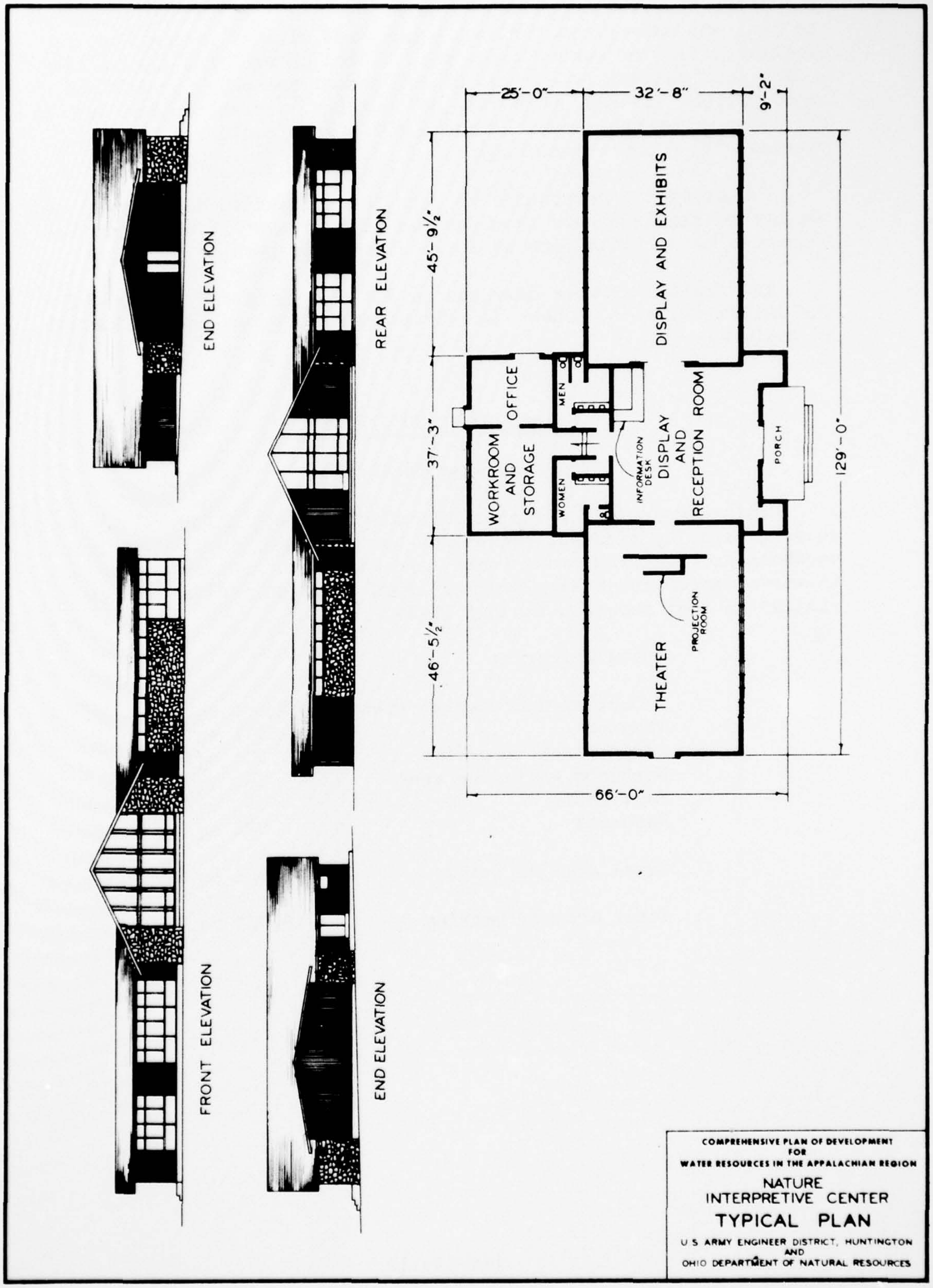

Exhibit 15-24

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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RESIDENT OUTDOOR EDUCATION CENTER

Center to include two dormitories, counselor quarters, administrative office, library, entry, lounge, meeting rooms, kitchen, food storage, rest rooms, and basement. Facilities to accommodate 48 people and 4 staff or counselors. Thirty parking spaces would serve facility. Plan based on typical layout similar to that shown on exhibits 15-25 and 15-26.

Space Criteria:

Kitchen and food storage area	1,462 sq.ft.
Dining area	1,296 sq.ft.
Meeting rooms and multi-purpose area	1,152 sq.ft.
Lounge	804 sq.ft.
Dormitory and counselor quarters	2,456 sq.ft.
Rest rooms	950 sq.ft.
Miscellaneous (library, office, entry, etc.)	1,500 sq.ft.
Basement (40 x 36) under kitchen	1,440 sq.ft.
Total Area of Center	11,060 sq.ft.
Total Area of parking	9,000 sq.ft.

TRAIL SYSTEM

Footpaths - 6' wide, natural earthen surface. System consists of 4 loop trails, and other connecting trails, of approximately 10 miles in length. Trails include trail A (2-1/2 miles), Trail B (4 miles), Trail C (2-3/4 miles), short Braille Trail (1/4 mile) off of Trail A, and 3/4 miles of connecting trails. One trail rest stop and bridges as needed.

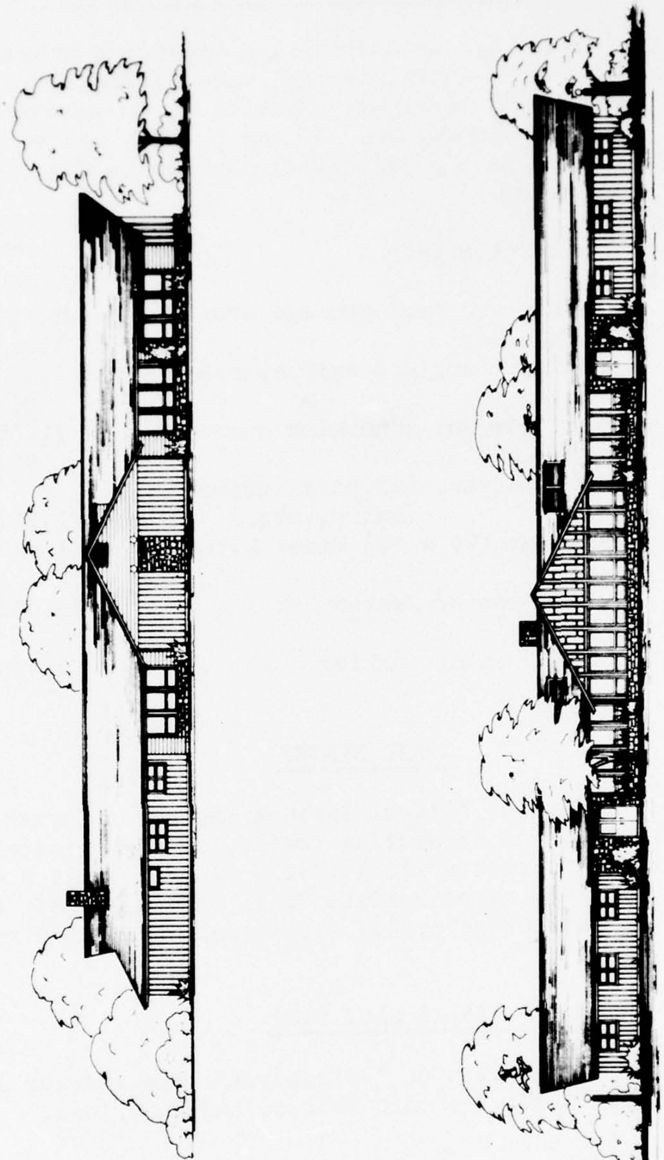
TRAIL REST STOP

Small cleared area with an "Adirondack" type shelter as illustrated on exhibit 15-27, 3 picnic tables, and firerings.

Space Criteria:

Rest Stop area (90' x 60')	5,400 sq.ft.
Adirondack shelter (20' x 12')	240 sq.ft.

Borrow areas, spoil areas, haul roads and clearing - Borrow for dam construction which cannot be removed from within the seasonal pool area and spillway cut would be scheduled for removal from other project land only after possible damage to project resources has been eliminated or minimized by integration of construction plans with the joint



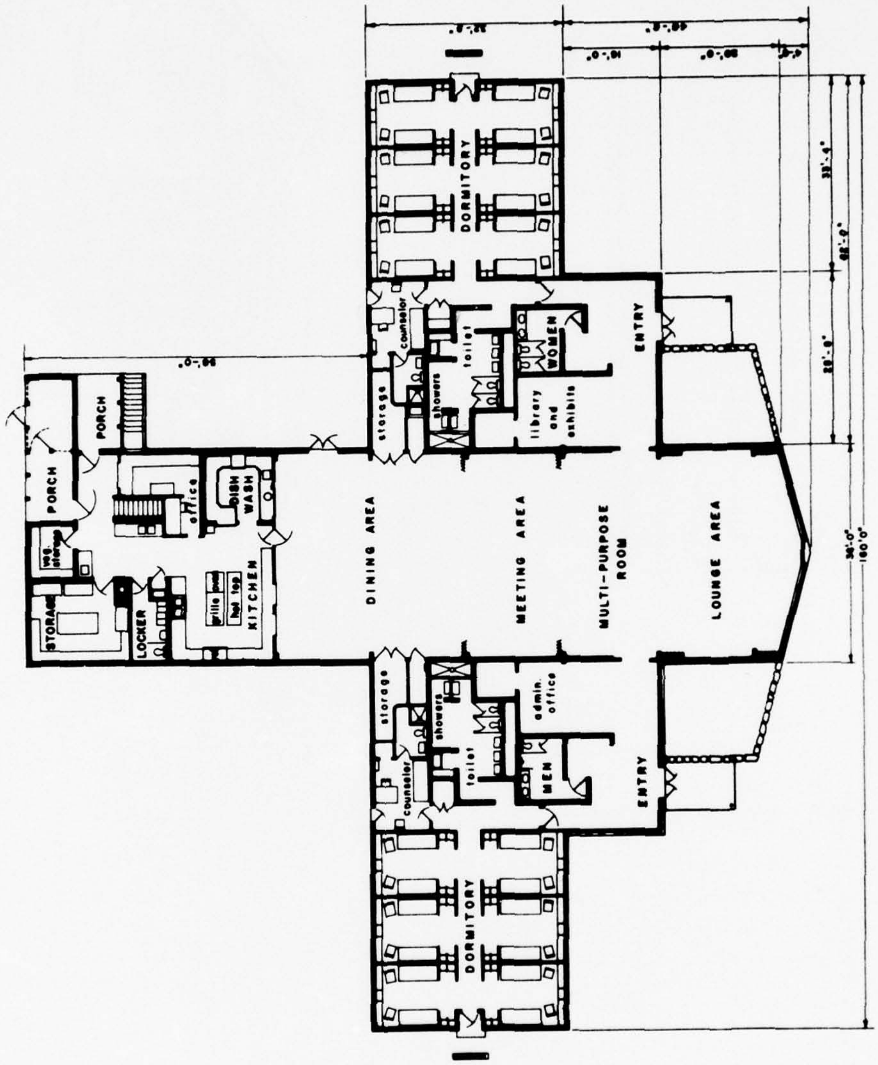
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

TYPICAL GROUP LODGE ADAPTABLE TO RESIDENT OUTDOOR EDUCATION CENTER

ELEVATIONS

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
AND
OHIO DEPARTMENT OF NATURAL RESOURCES

Exhibit 15-25

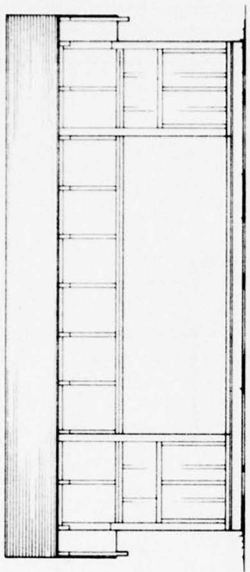


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

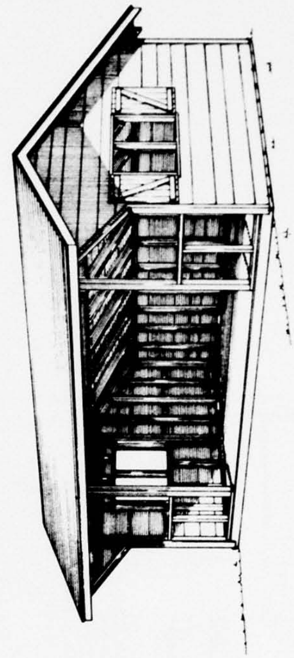
TYPICAL GROUP LODGE ADAPTABLE TO RESIDENT OUTDOOR EDUCATION CENTER
LAYOUT

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
AND
OHIO DEPARTMENT OF NATURAL RESOURCES

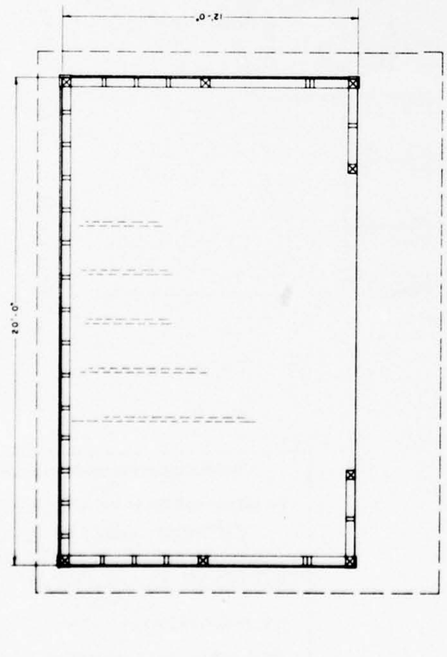
EXHIBIT 15-26



FRONT ELEVATION



PERSPECTIVE VIEW



FLOOR PLAN

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

TYPICAL TRAIL SHELTER

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
AND
OHIO DEPARTMENT OF NATURAL RESOURCES

Exhibit 15-27

Corps of Engineers - Ohio Department of Natural Resources environmental resource development master plan. The location of all spoil areas and haul roads would be selected, as with borrow areas, with a view to later incorporation into parking areas and access and circulation roads. Access and haul roads for clearing purposes will be located in the same manner as construction haul roads. Buildings and other structure removal above seasonal pool elevation will be similarly treated with a view toward use in the development plan. No burning will be permitted above seasonal pool elevation.

Relocation of roads, utilities, and cemeteries - Road and cemetery relocation will be achieved to accommodate the master plan for environmental resource development. Items for special emphasis are road alignment, borrow and spoil area location, and road construction criteria related to erosion control, landscaping, and visitor uses.

Abandonment of existing roads - All encumbrances on existing roads within the project boundary will be extinguished and the road right-of-way abandoned unless otherwise specified in the environmental resources development plan.

Scientific, historical, and aesthetic resources - The significance and disposition of existing resources in the first two categories (which include archeological and geological as well as the ecological features described above) will be more specifically defined during detailed post-authorization environmental resources planning. The project's scenic qualities are excellent, varying from a gorge-type relief with rock outcroppings and dense tree cover representative of the ecology of the glacial boundary in the lower reservoir to the moderately rolling relief characteristic of central Ohio's agricultural areas, in the upper reservoir. Important features will be marked for protection during project construction. The location of satellite interpretive centers and nature trails will be adjusted to include and highlight these features to supplement the outdoor recreation experience.

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SECTION IV - ECONOMIC EXPANSION CONSIDERATIONS

16. INDUSTRIAL EXPANSION

General - The construction of Logan Reservoir not only would prevent direct flood damages to the Hocking River Basin, but also would reduce the threat of flooding to potential industrial sites located in the vicinity of Logan and Athens, Ohio. The impact of the development of two potential industrial sites has been evaluated utilizing data obtained from a land use survey,*/ together with other available data. The land use questionnaires were sent to every manufacturing firm in the Appalachian portion of the Huntington District, employing 100 or more workers. Of the 342 questionnaires sent, 190 with usable information were returned. The information contained in these questionnaires was quantified and analyzed and this data served as a basis for evaluating the potential industrial expansion at Athens and Logan, resulting from the construction and operation of Logan Reservoir.

Athens Site - Athens County contains two parcels of land that possess a high degree of potential for industrial use if flood protection is provided. The larger parcel, containing approximately 72 acres, is located east of Athens between the Baltimore and Ohio Railroad on the south and U. S. Highway 50 on the north. The tract is occupied by the Ohio University Airport but this facility will be relocated in the near future. The smaller site, containing approximately 27 acres, is located west of Athens. The Hocking River bounds the property on the west and the Chesapeake and Ohio Railway forms the east border. No state or Federal highways border the property but highway access is available from West State Street.

Athens County's economic development may be hampered if additional land for industrial use is not available. The Logan Reservoir and the Athens LPP together will reduce the frequency of flooding of the possible industrial tracts and thereby enhance development potential. However, for such development to occur the land must be preserved for possible future industrial use. Consideration must be given to protection of these sites for eventual industrial use by restrictive zoning or control by agencies or interests concerned with promoting industrial development in the region. In analyzing these potential industrial sites, several very important assumptions must be made and the validity of the analysis is contingent upon the reasonableness of the assumptions. It must be assumed that the land will be available for future industrial use; it must be assumed that the land will be provided a high degree of flood protection; and most important, that the land will be used by industry.

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*/ Based on results obtained by questionnaire by a University of Cincinnati student.

It is difficult to anticipate the rate or sequence at which the potentially available land near Athens will be developed by industry. For this analysis, only one tract of potentially developable land was utilized in estimating the probable effects of the industrial expansion; however, it is recognized that both industrial sites near Athens could be developed concurrently.

It was assumed that the best potential site would be developed first and that the plant would be completed and operating by 1980. The target date of 1980 was selected for three reasons. If Logan Reservoir is constructed, the flood control storage would not be effective until about 1978 because of the review process and construction time required. Secondly, no industry probably would locate until the reservoir was effective and at least two years would be required to install the industrial facility. And lastly, the site judged to be the most desirable is now occupied by the Ohio University Airport and by 1980 the new airport should be in operation, thereby permitting use of the present airport site for industrial use.

The airport site was selected as the best potential site for the following reasons. The tract is fairly level and would require a minimum of site preparation. The industry could front on U. S. Highway 50, and such highway access is preferable to an industry. Two unpaved roads on the east and west ends of the property form a natural property boundary and could provide additional access. The site contains 72 acres and has adequate depth and width. (800 feet by 4300 feet).

The airport site is presently subject to flooding more often than once in five years. A flood with a return frequency of about once in 80 years, the approximate height of the adjacent railroad embankment, would inundate the site to a depth of about five feet. The construction and operation of Logan Reservoir in a system with the Athens Local Protection Project, would reduce the flood heights sufficiently so that the elevation of the railroad embankment berm would be higher than the 100 year level of flooding. By providing two short levees, one at each end of the potential site, tieing to high ground, and by providing an impervious blanket on the outside of the railroad embankment, protection exceeding the 100 year frequency of flooding with freeboard could be obtained. A pumping station of sufficient capacity would be required to discharge interior drainage from approximately 400 acres during periods of flooding. The downstream levee necessarily would cross U. S. Highway 50 to reach high ground. A highway traffic opening with closure would be required as a part of the protective measures.

The employment investment and water use resulting from industrial development of the airport site are presented in Table 15-22.

TABLE 15-22
EMPLOYMENT, INVESTMENT AND WATER USE
IF ATHENS INDUSTRIAL SITE IS DEVELOPED

Site Acreage	Employees */ per Developed Acre	New 1/ Employment	Investment */ per Employee	New 2/ Investment	Normal */ Water Use per Employee	Total 3/ Water Use
72	20	1440	$10,720	$15,436,800	.000724 MGD	1.6 cfs

*/ Factors from Land Use Survey; all heavy manufacturing (chemicals, primary metals, pulp and paper, and petroleum refining) were omitted from the analysis as it was considered unlikely that such firms would locate near Athens. The industries included in the sample are representative of light manufacturing, fabrication, and assembly type firms.

1/ New employment equals 72 acres multiplied by 20 employees per developed acre.

2/ New investment (1968 prices) equals 1440 new employees multiplied by $10,720 investment per employee.

3/ Total water use equals 1440 new employees multiplied by .000724 MGD which equals 1.042 MGD or 1.61 cfs.

Wages accruing to the new industrial employees were estimated by multiplying the 1967 average annual wage rate for manufacturing in Athens County of $5733, ("1967 Ohio Employment and Payroll by Industry for the State and Counties," Ohio Bureau of Unemployment Compensation) by the number of new employees, 1440. The total annual industrial wages were estimated to be $8,255,500.

In addition to the direct effects of a new industry, indirect effects would occur. Additional employment and wages in non-manufacturing enterprises probably would result because of the increased jobs in manufacturing (the export or basic industry). Using information contained in Recreation as an Industry by Robert R. Nathan Associates, Inc., and Resource Planning Associates, the probable indirect effects were estimated. According to the Nathan report, in the vicinity of Athens County for each direct addition to employment associated with the exogenous sector (manufacturing) there would be approximately 1.14

workers (multiplier of 2.14) added to the roles of employment in the endogenous sector - in local service and commercial activities indirectly resulting from the increase in direct exogenous employment. The indirect effect would be 1641 additional jobs in service and commercial type employment. The wages earned by these employees were estimated by multiplying the 1967 average annual wage by the number of new workers. The total service and commercial wages amount to $7,675,000, annually. Table 15-23 illustrates the computation of the average annual wage for non-manufacturing.

TABLE 15-23
NON-MANUFACTURING WAGES AND EMPLOYMENT
1967, FOR ATHENS COUNTY, OHIO

	Total Payroll		Total Employment		Average Annual Wage
Contract construction	$ 3,121,340		465		$6,713
Transportation & Utilities	6,299,091		921		6,839
Wholesale & Retail Trade	7,370,569		1962		3,757
Finance, Insurance, Real Estate	1,366,983		320		4,272
Services	2,215,033		688		3,219
	$20,372,394	÷	4356	=	$4,677

Source: Ohio Employment and Payroll by Industry for the State and Counties 1967, Ohio Bureau of Unemployment Compensation

The investment in non-manufacturing establishments associated with the 1641 indirect jobs was computed by using published census data and information contained in <u>Expansion Benefits Analysis for the Salyersville-Royalton Area Pilot Project</u> prepared for the Office of Appalachian Studies, United States Army Corps of Engineers by Spindletop Research Center, Lexington, Kentucky, March 1967.

Various other investments would be necessary to realize the full economic potential of the industrial development in addition to the plant and commercial facilities. These investments would include additional public facilities such as primary and secondary schools, transportation facilities, including highways and city streets; and residential developments, all of which would be necessary because of the increased population associated with imported labor for the new industrial development.

It was estimated that 25 percent of the 3081 total employees would be management, professional and skilled employees, and it was assumed they would be imported from outside the immediate region. It is recognized that some management, professional and skilled employees would probably come from the immediate area, but also that some semiskilled

and unskilled workers would come from outside the region's labor force. The remaining 75 percent of the new employees would be semiskilled and unskilled, would be previously unemployed or underemployed, and would be available from Athens and adjoining counties within commuting distance of the industrial site. The methodology for estimating the public and residential investment costs was primarily based on the data contained in the Salyersville-Royalton Report.

Table 15-24 summarizes the impact of the development of a potential industrial site near Athens.

TABLE 15-24
IMPACT OF INDUSTRIAL DEVELOPMENT
OF A 72 ACRE SITE NEAR ATHENS

Item	Impact
Investment (Initial)	
Industrial	$15,437,000
Commercial & Service	16,641,000
Public	1,600,000
Resident	12,400,000
Flood Protection	430,000
Total	$46,508,000
Employment	
Industrial	1,440
Commercial & Service	641
Total	2,081
Wages (Annual)	
Industrial	$ 8,255,000
Commercial & Service	7,675,000
Total	$15,930,000

Logan Site - There are three tracts of land possessing a high degree of potential for industrial development near Logan, Ohio. One tract of approximately 170 acres is located west of Logan and south of the Hocking River. The Chesapeake and Ohio Railroad borders the site on its northern extremity and Hocking Lake is to the south. A smaller site located northeast of Logan between Ohio Route 75 and Oldtown Creek contains about 34 acres. A spur line of the Chesapeake and Ohio Railroad extends to the southern limits of the property. The General Electric Company and the Wallace Murray Corporation have facilities located south of the site along Route 75. The third site

is located southeast of Logan and north of the Hocking River between old U. S. Highway 33 and the Chesapeake and Ohio Railroad. This site comprises approximately 35 acres and is the remaining portion of a 110-acre tract bounded by old U. S. 33 on the north, the Chesapeake and Ohio Railroad and new U. S. Highway 33 on the south, Old Town Creek on the west and old State Highway 328 on the east. Most of the 110 acre tract has been developed into an industrial park. The 35 acre site is adjacent to the Goodyear Tire and Rubber Company plant and south of the armory.

The latter site was deemed to be the best available potential industrial land for several reasons. Access to highway and rail transportation is excellent. The land is relatively level and site preparation would not be extensive. The property is owned by a local, non-profit, civic organization which has successfully promoted development in the industrial park, and is located in an area zoned for industrial development in the Logan future land use plan. (The Logan Comprehensive Plan, Report 2, prepared for the Logan City Planning Commission and Council by Carrol V. Hill & Associates, Columbus, Ohio, November 1963.)

The larger site containing 170 acres, was not selected as the best, because it is zoned in the future land use plan for medium density residential development. The property already is being encroached upon by residential development and its proximity to Lake Logan may make it undesirable for industrial use.

The site northeast of Logan has less desirable highway access than the selected site and there are no assurances that it will be made available for industrial use.

One serious shortcoming of the selected site is its vulnerability to rather frequent flooding from Hocking River backwater. A dike was constructed along Oldtown Creek in 1968, and with certain modifications to the dike the site would be protected from floods of about 35 year frequency. Prior to construction of the dike along Oldtown Creek, the potential site was subject to inundation more often than once every five years. A new U. S. Highway 33 is presently being constructed south of the industrial site and north of the Hocking River. A new interchange and roadway embankment are being constructed at the downstream end of the industrial park for relocated Ohio Highway 328. This embankment will provide protection from flooding to a height exceeding that of the Oldtown Creek dike. With the improvement of the Hocking River channel being accomplished by the State of Ohio in connection with the new highway construction and the additional channel improvement proposed by the Corps, the site would be protected by the dike and roadway embankment against floods of about 70 year frequency. The flooding protection frequency would be further increased to about once in 100 years, including limited freeboard, with Logan Reservoir in operation. Certain remedial work is necessary on the Oldtown Creek dike for it to function effectively as a part of the flood protection. The top and side of the

dike should be covered by an impervious layer to provide a uniform crest elevation and to reduce seepage through the embankment. The outside of the dike also should be covered by a layer of riprap to reduce bank erosion from Oldtown Creek headwater flooding. The dike and the new Highway 328 embankment connect with the Chesapeake and Ohio railroad embankment which forms the southern portion of the protection project. This embankment should be blanketed by an impervious layer to prevent possible seepage into the potential industrial site. All drainage structures through the railroad and highway embankments should be gated so they could be closed during flood periods.

During flooding conditions when all drainage structures are closed, a small pumping station would be required to remove the interior drainage from the site. This pumping facility could be located at an existing culvert under the railroad embankment near old Highway 328 just downstream from the Smead Corporation. The additional measures necessary to provide complete protection against floods of about 100-year frequency would be provided by non-Federal interest.

It was assumed that the industrial plant would be in place and operating by 1980. The target date of 1980 was selected for two reasons. If Logan Reservoir is constructed, the flood control storage would not be effective until 1978 because of the review process and construction time required. Secondly, industry probably would not locate until the reservoir was effective and at least two years would be needed to install the industrial facility.

Methodology used to evaluate the industrial development and associated development impact was similar to that used for the Athens site.

The employment, investment and water use resulting from industrial development of the site are presented in Table 15-25.

TABLE 15-25
EMPLOYMENT, INVESTMENT AND WATER USE IF SITE IS DEVELOPED

;ite :reage	Employees per developed acre	New employment	Investment per employee	New investment	Normal water use per employee	Total water use
35	20	700	$10,720	7,504,000	.000724 MGD	.79 cfs

Wages accruing to the new industrial employees were estimated by multiplying the 1967 average annual wage rate for manufacturing in Hocking County of $6117, ("1967 Ohio Employment and Payroll by Industry for the State and Counties," Ohio Bureau of Unemployment Compensation) by the number of new employees, 700. The annual industrial wages were estimated to be $4,282,000.

In addition to the direct effects of industrial expansion, indirect effects also would occur. Additional employment and wages in non-manufacturing would probably result because of the increase in jobs in manufacturing (the export or basic industry). According to the Nathan Report for the vicinity of Hocking County for each direct addition to employment associated with manufacturing there would be approximately .98 workers (multiplier of 1.98) added to the roles of employment in local service and commercial activities. The indirect effect would be 686 additional jobs (700 basic jobs times .98) in service and commercial type employment.

The wage benefits earned were estimated by multiplying the 1967 average annual non-manufacturing wage by the number of workers. The average annual wage of $4,726 1/, multiplied by the 686 additional non-manufacturing jobs equals $3,242,000 in wages. The investment in non-manufacturing establishments associated with the 686 indirect jobs was estimated at $7,296,000.

Certain other investments would be required because of the increased employment resulting from the complete development of the potential industrial site. It was estimated that 25 percent or 347 of the new industrial and commercial employees would be imported from outside the local labor market. Investments would be made in new facilities such as schools, hospitals, city streets, and residential developments which would be utilized by the new employees and their families. It was assumed that the remaining employees (semiskilled and unskilled) would be obtained locally within commuting distance of the potential industrial site and they would continue to utilize existing public and residential facilities.

Table 15-26 summarizes the impact of complete development of a potential industrial site near Logan, Ohio.

1/ Non-manufacturing wage for Hocking County from the following publication: "Ohio Employment and Payroll by Industry for the State and Counties 1967," Ohio Bureau of Unemployment Compensation.

TABLE 15-26
IMPACT OF INDUSTRIAL DEVELOPMENT OF
A THIRTY-FIVE ACRE SITE NEAR LOGAN

Item	Impact
Investment (Initial)	
Industrial	$ 7,504,000
Commercial & Service	7,296,000
Public	1,300,000
Residential	5,600,000
Flood Protection	120,000
Total	$21,820,000
Employment	
Industrial	700
Commercial & Service	686
Total	1,386
Wages (Annual)	
Industrial	$ 4,282,000
Commercial & Service	3,242,000
Total	$ 7,524,000

17. RECREATION EXPANSION

Developmental benefits result from wage payments made to persons within the region not directly associated with the project, but whose employment results from the economic activity induced by the water project development. Based upon studies conducted by the Corps of Engineers, it is estimated that ultimately 2,816,000 visitors will be attracted annually to the Park and Nature Area facilities at Logan Reservoir. Because of the proximity of Logan Reservoir to the Columbus, Ohio, metropolitan area, it was estimated that 65 percent of the total annual visitation would originate from within a 50-mile radius. Expenditures made by recreationists and tourists are considered to vary according to the distance traveled to reach the project. A portion of the total expenditures made by visitors to the

reservoir facilities will result in wages and salaries to persons whose employment was generated by the influx of monies into the region. Study report 24, of the Outdoor Recreation Resources Review Commission, indicates approximately 24 percent of the visitor expenditures accrue as wages and salaries to individuals. For this study, it was estimated that 25 percent of the visitor expenditure would result in wages and salaries. Considering the origin, route of travel and activities of the potential recreationists, it was estimated that 35 percent of their expenditures would occur within Appalachia, and therefore the resulting wages would accrue as benefits to the project. In addition to the basic wages resulting from visitor expenditure, secondary benefits would result because of the respending of the direct wages. This additional economic activity was evaluated utilizing appropriate county income multipliers as contained in the study, Recreation as an Industry. An average multiplier was calculated for the region, and it was applied to the basic wages resulting from the visitor expenditures to obtain the secondary effects. The combination of both produced the total economic impact to the region from recreation expenditures. The portion of the wages and salaries earned by workers previously unemployed or underemployed accrue as benefits to the National account. It was assumed that over a period of 20 years the region would gradually approach full employment. Accordingly, benefits to the National account were discounted to reflect this full employment condition in 20 years.

Expenditures made by recreationists and tourists will induce new commercial investment. This increased economic activity resulting from visitor expenditures in Appalachia has been evaluated and the amount of investment necessary to satisfy the demand for additional services is included as a developmental cost. Estimates of local expenditures by recreation users were based on the projected visitation and the amount of expenditures per visitor. The methodology for computing the private commercial investment demanded by the visitor expenditures, including multiplier effect, was based on data contained in the Salyersville-Royalton Report. Since the expenditures were based on visitation estimated to follow an accelerated growth pattern, investments in the commercial facilities were added as the visitation increased.

18. REDEVELOPMENT EXPANSION

Traditional redevelopment benefits consist of the basic wages earned in the construction, operation, and maintenance of the entire water resource project by persons within the Appalachian region. From an analysis of employment in the Appalachian and non-Appalachian counties within a 25-mile radius of the project it was estimated that 40 percent of the potential employee wages would be spent in Appalachian counties. Basic redevelopment benefits are discussed in detail in

Section VI, Benefits. In addition to these benefits, employee earnings would be generated by the respending of the initial wages within the region. These secondary redevelopment or developmental benefits to the region were evaluated by applying the appropriate county multipliers, as contained in the study, Recreation as an Industry, to the Appalachian portion of basic wage earnings from construction, operation and maintenance of the water project. Secondary redevelopment benefits accruing to the National account include wages to persons who in the absence of the water resource development and accompanying private development would be unemployed or underemployed. National account benefits resulting from operation and maintenance wages were discounted to reflect full employment conditions which are assumed to occur in 20 years.

Development of the water resource project will increase the demand for local goods and services. Wages earned by previously unemployed and underemployed persons working on project construction and operation and maintenance would increase economic activity in existing business and probably stimulate new commercial investment. It was assumed that existing commercial facilities would satisfy 50 percent of the increased demand for goods and service. The investments necessary to satisfy the remaining demand were calculated using a methodology similar to that previously discussed for recreation visitor expenditures.

19. NON-QUANTIFIED EXPANSION

Recreation regional impact - Due to the effects of glaciation, nearly all of the hilly, forested lands of Ohio lie in its southeastern quadrant. A large percentage of this land is within the Wayne National Forest. To date, approximately 113,000 acres have been purchased out of a gross area of 1,450,000 acres. State Forests in the region include Hocking, Tar Hollow, Richland Furnace, Zaleski and Waterloo.

An inventory of Ohio's existing Federal, State and major local recreation areas by the Bureau of Outdoor Recreation showed a concentration of State facilities in the central portion of southeastern Ohio. An inventory of potential recreation areas disclosed a similar concentration. Although there is a clear potential for recreation development, there are only 10,300 surface acres of natural or artificial lakes within the entire southeastern quadrant of the State. This total includes projects now under construction. For a land area of about 8,300 square miles including large areas otherwise suitable for major recreation development, the water acreages available are almost incidental.

Within the region, the Hocking Hills clearly stand out as an area of concentrated potential. They are the scenic and ecologic focal point of the region, if not the State. The Hocking Hills are a topographically distinct, unglaciated section located principally in western Hocking

County and extending into adjacent portions of surrounding counties. The deciduous forested hills also comprise a unique biotic area with concentrations of species once widespread in prehistoric times and which have survived the unique environment. The ecological environment of the hills has been widely studied for nearly a century. Several unique geologic land forms further add to the aesthetic interest of the area. These include Ash Cave, Cedar Falls, Rock House, Cantwell Cliffs, Conkles Hollow and Old Mans Cave. The State of Ohio has included each of these specific areas in the Hocking State Park and a scenic highway net ties the areas together.

Thus, the area of roughly 200 square miles contains an infinite variety of interest for recreationists and naturalists.

With the construction of a four-lane replacement for U. S. Route 33, the Hocking Hills will be within one hour's drive of Columbus at its closest point.

The potential of the area for extensive development is widely recognized. Referring to the entire region of southeastern Ohio, the Ohio Department of Natural Resources states in its "Statewide Plan for Outdoor Recreation," the recreational opportunities in this region are virtually unlimited. Yet in spite of its attraction, existing developments and easy access, the area's potential remains relatively untapped. There is almost no private development or tourist oriented accommodations in the Hocking Hills.

In large part, this condition can be explained by the fact that the entire region has a severe lack of water based recreation opportunities. The great pressure for outdoor recreation opportunities to be encountered throughout Ohio in the coming decades accentuates the economic impact that could be achieved by developing a recreation and tourism industry in southeastern Ohio. The desirability of such an impact emphasizes the need for water-based recreation development. The situation is amplified by a report titled, "Commercial Tourism Potential of Hocking County, Ohio," which was prepared for the Area Redevelopment Administration by the Division of Research, College of Business Administration, Ohio University. The following excerpts are from the report.

"For several years the College of Business Administration and Ohio University have been interested in the economic development of southeastern Ohio. Various programs have been undertaken in cooperation with area leaders toward this end. When the U. S. Army Corps of Engineers undertook a study of the Hocking River basin, the people of Hocking County saw the possible construction of recreation areas. They turned to Ohio University for assistance in determining what the future might be for the development of a tourist industry. As a result the College of Business Administration entered into a technical assistance contract with the Area Redevelopment Administration to study the commercial tourism potential of Hocking County."

"Hocking County is one of several southeastern counties with a limited economic development compared to the more prosperous counties in other regions of Ohio. A population of 20,168, attests in part to its economic limitations. Conditions which have hindered prosperity have been meager supplies of mineral resources, with the exception of coal resources, which in turn have limited industrial and manufacturing activities. Rugged topography and restricted areas of fertile soils have curbed any extensive agricultural development. Because the entire southeastern Ohio region has had similar limitations and because hilly landforms prevail, transportation facilities are not as extensive as elsewhere. These factors which have discouraged economic growth in the past are not likely to improve and aid future industrialization. Yet, there is strong pressure, however, from the people of Hocking County to maintain and, in fact, improve their economic status. One feasible means to aid economic conditions is to expand recreational facilities and to provide new ones. Facilities for all types of recreation are adding income to numerous communities in the United States as well as other parts of the world. Hocking County has certain advantages which can be utilized for increased recreation activities."

"Most of these more highly favored activities are just the type that Hocking County can offer in abundance. There is much hilly scenic countryside for the automobile drivers. Many places are suitable for walking and hiking. Excellent places are available for picnicking. These are relatively obvious advantages. Other complementary and supplementary facilities may be created to make Hocking County and all of southeastern Ohio a leading recreation area in Ohio and its neighboring states. Such additional resources may include individual attractions such as a visit to a coal mine, winter skiing, lodges and inns. Hocking County has a potential for a tourist industry. Perhaps, most important of all it needs extensive publicity and advertising."

"Present recreational opportunities which attract visitors to the area have been provided and are maintained by the State of Ohio. The Hocking caves are the primary attraction, while other nearby state recreation areas also attract visitors. There are very few privately operated recreational facilities and accommodations for visitors are limited."

"Methods of measuring the demand for tourism which an area can tap are still crude, but estimates of tourism potential need such measures. An attempt to estimate the number of tourists who can be attracted to Hocking County was based upon a study prepared for the Outdoor Recreation Resources Review Commission. On the basis of population and economic characteristics of Ohio and neighboring states, we feel Hocking County can serve as many as 23,000 vacation families. This group would spend about 90,000 family days in the area, about one half of which would occur in the summer months. With average

spending of $25 per family per day tourist spending could amount to over $2 million. On the basis of population projections, this figure could exceed $3 million by 1980. While this market exists, it can be tapped only if Hocking County develops tourist attractions and facilities and tells the market what it has to offer."

"The Hocking State Park consists of four major separate parcels of land in which are found six caves. Tentative plans of the Division of Parks are to integrate these parcels into one large holding of about 28,000 acres (roughly three times its existing size). To lure visitors the park relies primarily on the natural attraction of the six caves and gorges. With the exception of the campground near Old Man's Cave, there are almost no facilities to serve the visitor. Commercial development of the area has not occurred. The number of annual visitors exceeds three-quarters of a million people, but almost all come for short visits of a few hours because of the lack of accommodations."

"Several suggestions are made to increase the attractiveness of the caves and to increase their economic impact. Self-guided tours and campfire talks would allow visitors to learn of the geology, the flora, and the history of the park area in addition to enjoying its natural beauty. Steps can be taken to make the caves safer and more accessible during the winter months when their ice formations are spectacular. Publicity of the caves, both in and out of state, should be increased, and highway signs should be placed to aid the motorist in finding them. A restaurant should be opened in the vicinity of Old Man's Cave, which is the most popular of the six and the most centrally located."

"A common feature of recreation and commercial tourism is seasonality. The capital invested in facilities to serve tourists usually is unused or used very little during part of the year. The attractiveness of tourist facilities to the possible investor can be increased by lengthening his operating season. Interest in winter sports is growing in this country and with this growth goes increased opportunities for the businessman in the field of tourism. Skiing is the main attraction of winter resorts, but skating and tobogganing are a part. The hilly terrain of Hocking County fits the need of skiers, but natural snowfall cannot be depended upon to cover the slopes. Today, however, the resort owner is not so fully at the mercy of nature; he can make his own snow. Temperature conditions in the county are such as to make artificial snow feasible in December, January, and February. Since temperature variations occur in very small areas--between one hollow and the next, research must be done on any site considered by a prospective developer; but it appears that suitable winter sports sites do exist in Hocking County."

"Because different tourists have different interests, a region which seeks to make commercial tourism a healthy, vigorous industry must offer a recreational complex. There must be strong

forces to attract a visitor to a region, and a variety of recreational opportunities to excite his interest and make him want to stay or return again. It is from this standpoint that this report has developed several types of recreational activities to constitute a varied and interesting offering for future visitors to Hocking County. Some of these recommendations are tied to existing recreational facilities while others pertain to entirely new opportunities."

The gateway to the Hocking Hills is U. S. 33 on the northern edge of the area. Scenic routes 374 and 664 connect with U. S. 33 at Rockbridge and Logan, respectively. Clear Creek, which drains the northernmost extension of the hills, empties into the Hocking River just upstream of the junction of routes 374 and U. S. 33. This point at the entrance to the Nature Area is a 45 minute drive from downtown Columbus and a ten minute drive from Lancaster. Development of the State Park and Nature Area around Logan Reservoir, therefore, would provide a key link between the heavy population centers and the attractions of the Hocking Hills in general.

Logan Reservoir would identify with the Hocking Hills and vice versa. It would be possible to physically connect the project to other areas by means of hiking trails. The Buckeye Trail passes within about four miles of Neotoma Valley. A connecting trail would broaden the scope of the recreation development. It would tie the project area to the Wayne National Forest as well as to the Hocking and Tar Hollow State Forests. Another trail of less than two miles to the south would connect Neotoma to the Cantwell Cliffs Recreation Area. This latter area is only three miles from the dam site. The closest limits of the Hocking State Forest are only about one-half mile from the edge of the proposed Nature Area. Conceivably, the two areas eventually could be joined together. With the reservoir development added, the whole range of recreation and educational activities would be available, thereby, adding to the reputation of the area.

Certainly, the prospect of over 2,652,000 visitors annually at the reservoir alone combined with the increased interest in the area as a whole, would encourage private development of various tourist accommodations. In view of the great potential of the area, the state and local governments in turn would be encouraged to provide additional development and to expand existing facilities. The number of visitors attracted to the area then would greatly exceed the number anticipated at the reservoir itself. Visitor expenditures would exceed those ascribed directly to the reservoir, not only because of the increased number of visitors in the area, but also because of the increased duration of a visit made possible by new accommodations.

Based upon experience at other reservoirs, vacation homes and camps will be developed by the general public on private lands that are available and conveniently located with respect to the reservoir.

Other lakes that are more remote and harder to reach than the proposed Logan Reservoir have bustled with such development within two years after completion of the project. The main factor encouraging this development is the presence of roads around and into the recreation area. Although the State Park at Logan Reservoir would have limited access, there is an abundance of roads and developable land around the fringe area of the project. Enterprising land owners, foreseeing the possibilities of financial reward, will therefore subdivide their property for vacation home development.

It is concluded that the Logan Reservoir project could act as a catalyst for inducing further private and public investment in recreation facilities and tourist accommodations. Because of the proximity of the area to Columbus and Lancaster, vacation residences would be developed; further increasing local expenditures.

SECTION V - COST ESTIMATES

20. PROJECT COST

The capital cost as used in this section consists of the initial costs for such project items as lands and damages, relocations, dam and appurtenant works, facilities for recreation including fish and wildlife development, facilities for the nature preserve, engineering and design, and supervision and administration. It should be noted that the costs for recreation facilities required in the future to meet anticipated increases in demand are included as capital costs. All capital costs are usually referred to as construction costs and exclude interest incurred during construction. The total cost of construction of the Logan Reservoir is estimated to be $44,141,000, excluding associated private investment costs of $96,790,000. Table 15-27 summarizes the capital costs for Logan Reservoir. Detailed estimates of capital costs are shown in Table 15-28.

Investment costs are the sum of the capital cost and the accrued interests on those expenditures up to the time the project services become available. No interest during construction is computed on the capital cost for the future recreation facilities at the reservoir project since it is assumed that the construction funds will be appropriated and utilized on an annual basis. Interest during construction on all other capital costs was computed by multiplying the construction expenditure by an interest rate of 3.25 percent for one-half the construction period in years. The construction period for Logan Dam and Reservoir was assumed to be four years.

For the purposes of project evaluation, comparison of alternative projects, and for cost allocation; investment costs, adjustments for changes in land productivity rates, and costs of operation, maintenance and major replacement must be reduced to a common time basis, corresponding to benefit computations. Average annual charges were computed on the gross investment using the current Federal interest rate of 3.25 percent and an amortization period of 100 years. Operation and maintenance charges for the proposed developments are based on current costs of similar projects and include costs for major replacement items where applicable. Detailed estimates of the annual costs are shown in Table 15-29.

TABLE 15-27

SUMMARY OF CAPITAL COST

LOGAN DAM AND RESERVOIR PROJECT
(Based on prices prevailing in July 1968)

No.	Item	Cost	Cost with Items Nos. 8 and 9 distributed
1.	Lands and Damages 1/	$ 8,850,000	$ 8,850,000
2.	Relocations	3,700,000	4,370,000
3.	Reservoir	720,000	850,000
4.	Dam and Appurtenances	8,050,000	9,506,000
5.	Recreation 2/	15,257,000	18,221,000
6.	Nature Area	1,800,000	2,126,000
7.	Permanent Operating Equipment	185,000	218,000
8.	Engineering and Design	2,963,000	-
9.	Supervision and Administration	2,616,000	-
	Total Project Cost	$ 44,141,000	$ 44,141,000

1/ Includes $2,015,000 specifically for general recreation and $1,886,000 for the Nature Area.
2/ Includes future facilities cost of $3,629,000

TABLE 15-28

DETAILED ESTIMATE OF CAPITAL COST

LOGAN DAM AND RESERVOIR PROJECT
(July 1968 Prices)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES, JOINT USE LANDS				
Fee acquisition				
Home sites	Acre	100	$ 2,000	$ 200,000
Lakes (including structures)	Acre	25	2,000	50,000
Cropland (irrigated)	Acre	3	600	1,800
Cropland	Acre	4,484	350	1,569,400
Timberland	Acre	727	250	181,750
Pasture	Acre	1,192	190	226,480
Woodland	Acre	2,219	75	166,425
Subtotal, lands		8,750		$ 2,395,855

TABLE 15-28 (Cont'd)

LANDS AND DAMAGES, JOINT USE LANDS (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Improvements	Set	101	$ -	$ 1,145,000
Subtotal, Fee acquisition				$ 3,540,855
Severance damages	L.S.	-	-	131,000
Contingencies				885,145
Total, fee acquisition				$ 4,557,000
Easement acquisition				
Cropland	Acre	8	150	1,200
Pasture	Acre	9	125	1,125
Woodland	Acre	3	40	120
Subtotal, easement lands		20		2,445
Contingencies				555
Total, easement acquisition				$ 3,000
Minerals				
Subordination of Oil and gas rights	Acre	8,750	-	131,000
Contingencies				31,000
Total, minerals				$ 162,000
Administrative costs	Tract	145	1,200	174,000
Resettlement costs	Each	106	500	53,000
TOTAL LANDS AND DAMAGES, JOINT USE				$ 4,949,000

LANDS AND DAMAGES, SPECIFIC USE LANDS (RECREATION)

Item	Unit	Quantity	Unit Price	Amount
Fee acquisition				
Homesites	Acre	60	2,000	120,000
Croplands	Acre	530	350	185,500
Timberland	Acre	1,150	250	287,500
Pasture	Acre	820	190	155,800
Woodland	Acre	540	75	40,500
Subtotal, lands		3,100		$ 789,300

TABLE 15-28 (Cont'd)

LANDS AND DAMAGES, SPECIFIC USE LANDS (RECREATION) (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Improvements	Set	63	$ -	$ 630,000
Subtotal, fee acquisition				1,419,300
Severance damages	L.S.	-	-	67,000
Contingencies				354,700
Total, fee acquisition				$1,841,000
Minerals				
Subordination of Oil and gas rights	Acre	3,100	-	46,500
Contingencies				11,500
Total, minerals				$ 58,000
Administrative costs	Tract	70	1,200	$ 84,000
Resettlement costs	Each	64	500	$ 32,000
TOTAL SPECIFIC USE LANDS				$2,015,000

LANDS AND DAMAGES, NATURE AREA

Item	Unit	Quantity	Unit Price	Amount
Fee acquisition				
Homesites	Acre	45	2,000	90,000
Cropland	Acre	532	350	186,200
Timberland	Acre	1,120	250	280,000
Pasture	Acre	608	190	115,520
Woodland	Acre	1,495	75	112,125
Subtotal, land		3,800		$ 783,845
Improvements	Set	37	-	570,000
Subtotal, fee acquisition				$1,353,845
Severance damages	L.S.	-	-	48,000
Contingencies				338,155
Total, fee acquisition				$1,740,000

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES, NATURE AREA (Cont'd)				
Minerals				
Subordination of Oil and gas rights	Acre	3,800	$ -	$ 57,000
Contingencies				14,000
Total, minerals				$ 71,000
Administrative Costs	Tract	45	1,200	55,000
Resettlement Costs	Each	40	500	20,000
TOTAL LANDS AND DAMAGES, NATURE AREA				$ 1,886,000
TOTAL LANDS AND DAMAGES				$ 8,850,000
RELOCATIONS				
Highways				
County roads	Mile	3.63	-	$ 2,200,000
Township roads	Mile	1.44	-	250,000
Subtotal, roads		5.07		$ 2,450,000
Utilities				
Power lines	L.S.	-	-	62,000
Telephone lines	L.S.	-	-	101,000
Pipe lines	L.S.	-	-	142,000
Subtotal, utilities				$ 305,000
Cemeteries (2)				
Graves	Each	760	350	$ 270,000
Beautification	L.S.	-	-	55,000
Subtotal, relocations				$ 3,080,000
Contingencies				620,000
TOTAL, RELOCATIONS				$ 3,700,000

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
RESERVOIR				
Clearing reservoir	Acre	900	$ 250	$ 225,000
Clearing reservoir (for W.S.)	Acre	1,100	250	275,000
Boundary marking	Mile	50	2,000	100,000
Subtotal, reservoir				$ 600,000
Contingencies				120,000
TOTAL, RESERVOIR				$ 720,000
DAM AND APPURTENANCES				
Dam and Spillway				
Care & diversion of water	L.S.	1	$ -	$ 75,000
Foundation dewatering sys.	L.S.	1	-	125,000
Field office	L.S.	1	-	60,000
Clearing & grubbing	Acre	80	450.00	36,000
Excavation				
Common	C.Y.	480,000	1.00	480,000
Rock	C.Y.	450,000	1.80	810,000
Excavation, borrow				
Impervious	C.Y.	565,000	1.10	621,500
Stripping	C.Y.	94,000	0.60	56,400
Embankment				
Impervious earth	C.Y.	450,000	0.20	90,000
Random rock	C.Y.	368,000	0.25	92,000
Transition & blanket drain	C.Y.	127,000	4.00	508,000
Riprap, dumped	C.Y.	21,000	7.00	147,000
Bedding material	C.Y.	7,000	3.50	24,500
Foundation grouting	L.S.	1	-	140,000
Barrier fence	L.F.	2,600	15.00	39,000
Guard rail	L.F.	1,700	4.00	6,800
Roadway surfacing	S.Y.	1,600	1.75	2,800
Concrete, spillway weir	C.Y.	300	40.00	12,000
Cement	Bbl.	600	5.50	3,300
Reinforcing steel	Lb.	30,000	0.17	5,100
Anchor bars	L.F.	1,600	3.00	4,800
Drain holes	L.F.	1,600	4.00	6,400
Instrumentation	L.S.	1	-	50,000
Gaging station & cableway	L.S.	1	-	40,000
Seeding	Acre	40	400.00	16,000
Subtotal, Dam and Spillway				$ 3,451,600
Contingencies				648,400
Total, Dam and Spillway				$ 4,100,000

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES (Cont'd)				
Outlet Works				
Clearing & grubbing	Acre	14	$ 450.00	$ 6,300
Excavation				
Common	C.Y.	90,000	1.30	117,000
Rock	C.Y.	150,000	3.00	450,000
Tunnel & transition	C.Y.	5,700	30.00	171,000
Dumped riprap	C.Y.	1,600	7.00	11,200
Bedding material	C.Y.	800	3.50	2,800
Concrete				
Service bridge, abutment	C.Y.	50	70.00	3,500
Intake structure	C.Y.	5,500	60.00	330,000
Transition	C.Y.	330	70.00	23,100
Tunnel	C.Y.	3,020	50.00	151,000
Stilling basin	C.Y.	700	50.00	35,000
Cement	Bbl.	14,600	5.50	80,300
Reinforcing steel	Lb.	1,050,000	0.17	178,500
Drain holes, stilling basin	L.F.	1,900	4.00	7,600
Anchor bars, grouted	L.F.	1,600	3.50	5,600
Drilling & grouting tunnel	L.S.	1	-	50,000
Roof bolts	L.F.	10,300	3.00	30,900
Barrier fence	L.F.	1,000	15.00	15,000
Waterstops	L.F.	880	5.00	4,400
Steel, transition supports	Lb.	60,000	0.50	30,000
5'-8"x10'-0" main control gates & liners	Ea.	2	60,000.00	120,000
Low flow control valve assembly	Ea.	1	24,000.00	24,000
Multiple level intake gates	Ea.	3	6,000.00	18,000
Hydraulic system for control gates	L.S.	1	-	30,000
Emergency gates, guides & recess armor	L.S.	1	-	40,000
Multiple level intake bulkheads, guides & recess armor	L.S.	1	-	10,000
Precast trash rack beams	Ea.	8	175.00	1,400
Floatwell system	L.S.	1	-	10,000

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES (Cont'd)				
Outlet Works (Cont'd)				
Water temperature recording system	L.S.	1	$ -	$ 5,000
Traveling crane	L.S.	1	-	40,000
Plumbing & water supply	L.S.	1	-	10,000
Heating & ventilating system	L.S.	1	-	25,000
Electrical work	L.S.	1	-	35,000
Emergency generator	L.S.	1	-	15,000
Aluminum handrailing	L.F.	600	15.00	9,000
Tile gage	L.S.	1	-	4,000
Air vent system	L.S.	1	-	20,000
Miscellaneous metal	L.S.	1	-	20,000
Architectural work	L.S.	1	-	30,000
Portable gantry crane	L.S.	1	-	2,500
Service bridge superstructure	L.S.	1	-	45,000
Seeding	Acre	10	250.00	2,500
Subtotal, Outlet Works				$ 2,219,600
Contingencies				480,400
Total, Outlet Works				$ 2,700,000
Access Road				
Clearing & grubbing	Acre	20	450.00	9,000
Exc. unclassified	C.Y.	200,000	1.50	300,000
Culverts, 18" diameter	L.F.	100	10.00	1,000
24" diameter	L.F.	50	14.00	700
30" diameter	L.F.	100	18.00	1,800
Headwalls	L.S.	1	-	3,500
Guard rail	L.F.	4,500	4.00	18,000
12" granular fill	C.Y.	10,000	8.00	80,000
5" subbase	C.Y.	2,800	8.00	22,400
6" crushed agg. base	C.Y.	3,000	10.00	30,000
Prime coat	Gal.	3,600	0.50	1,800
4" asphaltic concrete	C.Y.	2,000	25.00	50,000
Seeding	Acre	10	400.00	4,000
Improve 2.17 miles of TWP 113	L.S.	1	-	350,000
Subtotal, Access Road				$ 872,200
Contingencies				127,800
Total, Access Road				$ 1,000,000

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
DAM AND APPURTENANCES (Cont'd)				
Beautification	L.S.	-	$ -	$ 250,000
TOTAL, DAM AND APPURTENANCES				$ 8,050,000
GENERAL RECREATION AND FISH AND WILDLIFE				
Initial development				
Facilities cost 1/	L.S.	-	-	9,690,000
Contingencies				1,938,000
Total, initial development				$11,628,000
Future development				
Facilities cost 1/	L.S.	-	-	3,024,600
Contingencies				604,400
Total, future development				$ 3,629,000
TOTAL GENERAL RECREATION AND FISH AND WILDLIFE				$15,257,000
NATURE AREA				
Initial development				
Facilities cost 2/	L.S.	-	-	$ 1,565,000
Contingencies				235,000
Total, initial development				$ 1,800,000
Future development				
Facilities cost		-	-	0
TOTAL, NATURE AREA				$ 1,800,000

1/ See Table 15-31 for details.

2/ See Table 15-36 for details.

TABLE 15-28 (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
PERMANENT OPERATING EQUIPMENT				
Operator's quarters	Ea.	2	$ 15,000.00	$ 30,000
Tractor, truck, boat, mower, tools, etc.	Lot	1	-	15,000
Utility building	Job	1	-	7,000
Rainfall and discharge stations				
Inflow station	Job	1	-	20,000
Lake gage (on intake struct.)	Job	1	-	4,000
Equipment for discharging station at dam	Job	1	-	2,000
Outflow station (dwnst.)	Job	1	-	20,000
Equipment for W.Q.C.	Job	1	-	10,000
Rainfall gages	Ea.	4	350.00	1,400
Radio facilities	Job	1	-	25,000
Beautification (oper. quarters)	Job	1	-	20,000
Subtotal				$ 154,400
Contingencies				30,600
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 185,000
ENGINEERING AND DESIGN				
Initial development	L.S.	-	-	$2,600,000
Future increment	L.S.	-	-	363,000
TOTAL, ENGINEERING AND DESIGN				$2,963,000
SUPERVISION AND ADMINISTRATION				
Initial development	L.S.	-	-	$2,119,000
Future increment	L.S.	-	-	497,000
TOTAL, SUPERVISION AND ADMINISTRATION				$2,616,000

TABLE 15-29

DETAILED ESTIMATE OF ANNUAL COST
LOGAN MULTIPLE PURPOSE RESERVOIR PROJECT

Item	Financial Costs	Economic Costs
a. Total investment		
(1) Recapitulation of project costs		
(a) Initial costs	$ 39,652,000	$ 39,652,000
(b) Incremental costs	4,489,000	4,489,000
(c) Market value of lands	-	(4,961,250)
(2) Interest during construction (initial costs only) at 3-1/4% for 1/2 of construction period of 4 years	2,577,400	2,577,400
(3) Total gross investment	$ 46,718,400	$ 46,718,400
b. Annual initial costs		
(1) Interest on gross investment		
(a) Recreation	$ 545,000	$ 545,000
(b) Nature area	73,600	73,600
(c) Remaining costs (23,194,600) (0.0325)	753,800	753,800
(d) Adjustment for net loss of land (5%-3-1/4%) (4,961,250)	-	86,800
(2) Amortization		
(a) Recreation	23,100	23,100
(b) Nature area	3,100	3,100
(c) Remaining costs (23,194,600) (0.00138)	32,000	32,000
(3) Maintenance and operation		
(a) Dam and reservoir	50,000	50,000
(b) Water quality control & water supply	5,000	5,000
(c) Recreation	280,400	280,400
(d) Nature area	89,400	89,400
(4) Major replacements		
(a) Dam and reservoir	2,000	2,000
(b) Water quality control & water supply	200	200
(c) Recreation	97,700	97,700
(d) Nature area	15,100	15,100
(5) Total annual initial costs	$1,970,400	$2,057,200

TABLE 15-29 (Cont'd)

c. Annual future recreation incremental costs		
(1) Interest	$ 78,800	$ 78,800
(2) Amortization	3,300	3,300
(3) Maintenance and operation	143,700	143,700
(4) Major replacements	16,100	16,100
(5) Total future increment	$ 241,900	$ 241,900
d. Total Annual Costs	$2,212,300	$2,299,100

Cost of reservoir recreation features. Facility costs for general recreation development were estimated for the potential reservoir considered. Cost estimates were developed for facilities necessary to satisfy the anticipated initial and future usages. Comparison of the total estimated facility needs with the facilities that will be provided initially shows that a need for additional facilities will be in evidence immediately after project completion and will continue into the future for a project life of 100 years.

After a reasonable indication of demand was determined for the project, preliminary recreation site locations were developed in order to estimate the capacity of the Logan Project for optimum use. In the siting, scaling and design of the recreational facilities required to satisfy the estimated demand, usage percentage factors were applied to each individual type of project activity. These factors took into account usages prevailing in nearby projects, project accessibility to densely populated areas, local desires and the topography of the reservoir area.

The initial and future design loads were then used to estimate the type and quantity of facilities to which unit costs were applied to arrive at total facility costs. Multiple level intakes would be provided to control depth from which releases are made in order to regulate oxygen content and temperatures for fishing enhancement and for water quality control. The access roads, launching facilities and parking spaces needed for fishing and hunting will be provided for general recreation purposes and should be sufficient for both functions since the peak usage for the different activities normally would not occur simultaneously.

Additional lands consisting of approximately 3,100 acres located around the periphery of the basic project would be acquired specifically for recreation and will be used jointly between the general and the fish and wildlife recreation purposes of the project. Enough land downstream from the dam would be provided for an adequate tailwater fishery. Table 15-30 summarizes the recreation investment costs.

TABLE 15-30

LOGAN RESERVOIR

SUMMARY OF GENERAL RECREATION AND FISH AND WILDLIFE INVESTMENT COSTS

Item	Initial	Future	Total
1. General recreation facilities	$ 9,379,500	$ 3,024,600	$12,404,100
Contingencies	1,875,900	604,400	2,480,300
Subtotal	11,255,400	3,629,000	14,884,400
ED & SA	2,036,700	860,000	
Total facilities	13,292,100	4,489,000	17,781,100
Specific recreation lands 1/	2,015,000	0	2,015,000
Total lands & facilities	15,307,100	4,489,000	19,796,100
Interest during const. 2/	995,000	0	995,000
General recreation investment	$16,302,100	$ 4,489,000	$20,791,100
2. Fish and wildlife facilities 3/	$ 145,500	$ 0	$ 145,500
Contingencies	29,100	0	29,100
Subtotal	174,600	0	174,600
ED & SA	31,600	0	31,600
Total apportioned facilities	206,200	0	206,200
Specific fishing facilities	125,000	0	125,000
Contingencies	25,000	0	25,000
Subtotal	150,000	0	150,000
ED & SA	27,100	0	27,100
Total specific fishing facilities	177,100	0	177,100
Hunting management unit facilities 4/	48,000	0	48,000
ED & SA	8,600	0	8,600
Total hunting management & facilities	56,600	0	56,600
Total fish and wildlife activities	439,900	0	439,900
Specific fish and wildlife lands	0	0	0
Total lands and facilities	439,900	0	439,900
Interest during const.	28,600	0	28,600
Fish and wildlife investment	468,500	0	468,500
TOTAL RECREATION INVESTMENT COSTS	$16,770,600	$ 4,489,000	$21,259,600

1/ Includes administrative costs and contingencies

2/ Initial only - 1/2 of construction period of 4 years @ 3.25% = 6.50%

3/ F&W shares some General Recreation Facilities in proportion to user days excluding tailwater fishery and hunting management visitation: $\frac{30,850\ (12,549,000)}{2,682,850} = 145,500$

4/ Furnished by State of Ohio Division of Wildlife (includes contingencies)

For purposes of sub-allocation of costs, a proportionate share of the facilities cost to be shared equally by fish and wildlife and general recreation have been allocated to fish and wildlife function.

Details of the initial and future capital cost of recreation facilities for the formulated plan are presented in Table 15-31. For the purposes of project evaluation and cost allocation, investment costs and charges for operation, maintenance and major replacements for recreational facilities must be reduced to a common time basis. Facilities cost by activity are listed in Table 15-32.

The sum of all annual cost items shown in Table 15-33 gives the total annual charges. The cost for the future increment of recreation has been distributed equitably over the 100-year life of the project. The derivation of average annual costs is given in Table 15-34. For cost allocation purposes, the average annual alternative cost for equivalent single purpose recreation was derived through application of statistics for similar development in the State of Ohio. The derivation is shown in Table 15-35.

Cost of nature area features. The potential Clear Creek Nature Area, as presently planned by the Ohio Department of Natural Resources, would include most of the land below the dam site from ridge to ridge, to a point at which U. S. Route 33 crosses Clear Creek. The 3,800-acre area would have a resident outdoor education center, a nature interpretive center, approximately ten miles of hiking and nature trails and the Neotoma Ecological Research Area. The facilities were designed to fit the scale and purpose of the nature area. The detailed cost of these facilities are presented in Table 15-36. The derivation of the average annual costs is given in Table 15-37.

21. DEVELOPMENTAL COSTS

The water resource developmental plan will require non-Federal investments in order to realize the full economic potential of the project. Investments would be required to develop the new industrial sites, including plant, equipment, real estate, utilities, parking and flood protection. Other investments would be made in new commercial facilities needed to supply the increased demand for goods and services created by the added purchasing power resulting from expanded industrial employment, employment opportunities induced by recreation visitor expenditures and employment on water project construction operation and maintenance. Certain additional public and residential facilities would be required because of the increase in population associated with new industrial and commercial employment.

Two potential industrial sites were evaluated in connection with the Logan Reservoir developmental plan, one site near Athens, and another site near Logan. The site near Athens is at the present location of the Ohio University Airport and comprises approximately 72 acres. It

TABLE 15-31

DETAILED ESTIMATE OF GENERAL RECREATION AND
FISH AND WILDLIFE FACILITIES COSTS
LOGAN RESERVOIR, OHIO

Item	Unit	Unit Cost	Initial		Future		Total	
			Quantity	Amount	Quantity	Amount	Quantity	Amounts
FACILITIES - General Recreation and Fish and Wildlife Recreation								
Roads								
Access	Mile	$105,000	16	$ 1,680,000	-	$ -	16	$ 1,680,000
Circulation	Mile	105,000	9	945,000	8.5	892,500	17.5	1,837,500
Picnic units	Each	500	612	306,000	647	323,500	1,259	629,500
Camping units	Each	500	650	325,000	690	345,000	1,340	670,000
Parking	Spaces	400	1120	448,000	1205	482,000	2,325	930,000
Parking (cars & trailer)	Spaces	500	225	112,500	275	137,500	500	250,000
Launching ramps	12' lanes	2500	9	22,500	11	27,500	20	50,000
Restrooms (incl water dist system sewage disposal, water supply)	Units	60,000	13	780,000	14	840,000	27	1,620,000
Rest rooms (incl. laundry & showers, water supply, dist. system & sewage disposal)	Unit	80,000	26	2,080,000	28	2,240,000	54	4,320,000
Beach (2)	S.F.	5	113,000	565,000	120,000	600,000	233,000	1,165,000
Beach house (2)	Job	-	Job	400,000	-	-	Job	400,000
Overlook & interpretation	Job	-	Job	25,000	-	-	Job	25,000
Trails	L.F.	6	20,000	120,000	30,000	180,000	50,000	300,000
Excavation	Job	-	Job	100,000	-	-	Job	100,000
Lighting (buried)	L.S.	-	L.S.	110,000	L.S.	100,000	L.S.	210,000
Landscape - planting	Job	-	Job	731,000	Job	532,000	Job	1,263,000
Subtotal, facilities				$ 8,750,000		$ 6,700,000		$ 15,450,000
Contingencies				1,300,000		1,000,000		2,300,000
TOTAL COST GENERAL RECREATION AND FISH AND WILDLIFE RECREATION FACILITIES				$10,050,000		$ 7,700,000		$ 17,750,000

TABLE 15-32

LOGAN RESERVOIR
RECREATION FACILITIES COST SUMMARY BY ACTIVITY

	Initial	Future	Total
Picnicking	$ 2,035,000	$ 955,000	$ 2,990,000
Swimming	906,400	228,000	1,134,400
Camping	4,193,200	1,619,000	5,812,200
Boating	379,500	-	379,500
Commissary	160,000	-	160,000
Amphitheater	165,000	-	165,000
Overlook & Interpret.	25,000	-	25,000
Trails	103,000	122,100	225,100
Tailwater Access	125,000	-	125,000
Fish & Wildlife	40,000	-	40,000
Utilities & Landscaping	1,557,900	100,500	1,658,400
Sub-total	9,690,000	3,024,600	12,714,600
Contingencies ± 20%	1,938,000	604,400	2,542,400
TOTAL	$11,628,000	$3,629,000	$15,257,000

TABLE 15-33

LOGAN RESERVOIR
SUMMARY OF GENERAL RECREATION AND FISH AND WILDLIFE ANNUAL COST

Item	Initial	Future	Total
1. Annual charges 1/			
Operation and maintenance	$ 280,400	$ 143,700	$ 424,100
Interest	545,000	78,800	623,800
Amortization	23,100	3,300	26,400
Major replacements	97,700	16,100	113,800
2. Total financial annual charges	$ 946,200	$ 241,900	$1,188,100

1/ See Table 15-26 for derivation of annual costs

TABLE 15-34

LOGAN RESERVOIR
ANNUAL COST DERIVATION - GENERAL AND FISH AND WILDLIFE RECREATION

OPERATION & MAINTENANCE

Initial 1,365,850 1/ x 0.20	$ 273,200
Wildlife Management Unit 2/	7,200
Total initial	$ 280,400
Future 1,326,000 3/ x .20 x .5418 4/	143,700
Avg. Annual O&M	$ 424,100

INTEREST

Initial 16,770,600 x 0.0325	$ 545,000
Future 4,489,000 x 0.0325 x 0.5401 5/	78,800
Avg. Annual Interest	$ 623,800

AMORTIZATION

Initial 16,770,600 x 0.00138	$ 23,100
Future 4,489,000 x 0.00138 x 0.5401 5/	3,300
Avg. Annual Amortization	$ 26,400

MAJOR REPLACEMENTS

Initial 11,628,000 x 1/3 x 0.0252 6/	$ 97,700
Future 3,629,000 x 1/3 x 0.0133 7/	16,100
Avg. Annual Major Replacements	$ 113,800

TOTAL AVERAGE ANNUAL COSTS (FINANCIAL) $1,188,100

1/ Total visitation, initial (does not include wildlife visitation of 4,500)
2/ Estimated by State of Ohio Division of Wildlife.
3/ Total visitation, future
4/ Average annual equivalent factor for O&M for pattern of accelerated growth assumed
5/ Average annual equivalent factor for interest and amortization
6/ Average annual equivalent factor for major replacement of initial facilities
7/ Average annual equivalent factor for major replacement of future facilities

TABLE 15-35
ALTERNATIVE ANNUAL COST DERIVATION
GENERAL AND FISH AND WILDLIFE RECREATION

General Recreation	
Initial visitation	1,326,000
Future visitation	1,326,000
Total, general recreation visitation	2,652,000
Fish and Wildlife	
Initial visitation	44,350
Future visitation	0
Total, Fish and Wildlife visitation	44,350
Ultimate annual visitation	2,696,350
Average annual visitation (2,652,000 x .8789 + 44,350)	2,287,300
Alternative project acreage required to provide equivalent level of total recreation benefits	11,600
Average annual density 2,287,300 ÷ 11,600	197
Average annual value per visitor day (Technical paper No. 2)	0.59
Average annual value escalated to July 1968 prices	0.82
Total alternative annual economic cost (2,696,350 x .82 x .7622)	1,685,200

TABLE 15-36
DETAILED ESTIMATE OF NATURE AREA COSTS
LOGAN RESERVOIR

Item	Unit	Unit Cost	Initial Quantity	Initial Amount
FACILITIES - Nature Area				
Access roads	Mile	$ 105,000	4	$ 420,000
Nature Interpretive Center	Job	-	-	182,300
Outdoor Education Center	Job	-	-	336,300
Trail system	Job	-	-	66,000
Trail rest stop	Job	-	-	3,400
Paths, signs	L.S.	-	-	30,000
Control station	Job	-	-	25,000
Relocated covered bridge	L.S.	-	-	120,000
Fencing Neotoma	L.F.	5	20,000	100,000
Restrooms with water supply, dist. system, sewage disposal	Unit	60,000	2	120,000
Power, buried	L.F.	6	5,000	30,000
Parking, fishing	Spaces	400	100	40,000
Landscape - planting	Job	-	-	92,000
Subtotal, facilities				$ 1,565,000
Contingencies				235,000
TOTAL COST, NATURE AREA				$ 1,800,000

TABLE 15-37
LOGAN RESERVOIR
ANNUAL COST DERIVATION - NATURE AREA

OPERATION & MAINTENANCE	
Initial 1/	$ 89,400
INTEREST	
Initial 2,264,200 x 0.0325	$ 73,600
AMORTIZATION	
Initial 2,264,200 x 0.00138	$ 3,100
MAJOR REPLACEMENTS	
Initial 1,800,000 x 1/3 x 0.0252	$ 15,100
TOTAL AVERAGE ANNUAL COSTS (FINANCIAL)	$181,200

1/ Estimated by State of Ohio Department of Natural Resources.

was estimated that utilization of the site would create employment for 1,440 industrial workers. Using data from a land use survey*/ the cost of industrial development of this site was estimated to be $10,720 per employee or a total of $15,437,000 for the entire site. This cost includes buildings, equipment, real estate, utilities, etc. necessary for a complete plant facility. In addition to industrial costs, other associated investments would be required and these are categorized as: commercial, public, residential and flood protection. It was determined that 1641 commercial and service type jobs would result because of the induced industrial expansion. Using a methodology as developed in the Salyersville-Royalton Report, and data for various economic and census publications, the commercial investment at Athens was determined as presented in the following tabulation:

TABLE 15-38

COMMERCIAL INVESTMENT, ATHENS, OHIO

Item	Quantity	Source
New employees	1641	Calculation,
Employees per establishment	5	City and County Data, Book 1967 U. S. Dept. of Commerce, 1967
Number of establishments associated with new employees	328	Calculations (1641 ÷ 5)
Sales per establishment	$152,200	City-County Data Book
Sales	$49,921,600	Calculations (328 x 152,200)
Sales per square foot of building	$60	Expansion Benefit Analysis
Square feet of buildings	832,030	Calculations (49,921,600 ÷ $60)
Investment per square foot*	$20	Expansion Benefits Analysis and Calculations
Investment	$16,641,000	Calculations (20 x 832,030)

*Investment per square feet of building based upon development of a 5-acre commercial lot including building equipment, real estate, utilities and parking facilities. The cost data were revised to 1969 price levels.

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*/ Based on results obtained by questionnaire by a University of Cincinnati student.

The potential industrial site near Logan is the remaining 35 acre portion of an industrial park. It was estimated that this site, fully developed by industry, would employ 700 persons, with the total industrial investment estimated to be $10,720 per employee or $7,504,000. Based on a multiplier of .98 for Hocking County, it was calculated that 686 additional commercial and service type jobs would result because of the industrial development. Using the methodology described for the site near Athens, the commercial investment required for the Logan site was determined in accordance with the following tabulation:

TABLE 15-39
COMMERCIAL INVESTMENT, LOGAN, OHIO

Item	Quantity	Source
New Employees	686	Calculations,
Employees per establishment	5	City and County Data, Book 1967, U. S. Dept. of Commerce, 1967
Number of establishments associated with new employees	137	Calculation (686 ÷ 5)
Sales per establishment	$159,770	City and County Data Books
Sales	$ 21,888,500	Calculations (137 x 159,770)
Sales per square foot of building	$60	Expansion Benefit Analysis
Square feet of building	364,800	Calculations (21,888,500 ÷ $60)
Investment per square foot*	$20	Expansion Benefit Analysis and Calculation
Investment	$7,296,000	Calculations ($20 x 364,800)

*Footnote - see table 15-38

The total initial industrial and commercial investment for the two sites is $46,880,000. This investment was considered to be 50 percent structure with 50-year useful life and 50 percent equipment with 25-year useful life. Major replacement costs were phased in accordance with these assumptions for the 100 year project life. All replacement investments were converted to present worth values by use of 3.25 percent interest and amortization rates. The accumulated present worth of the non-Federal investments then were discounted over the 100 year project life at five percent interest rate. Summaries of the investment costs and annual charges are presented in Table 15-40.

In determining the public facility and residential cost it was estimated that 25 percent of the total of 3,081 new employees at Athens would be management, professional and skilled and that they would be imported from outside the regional labor force. To accommodate this

TABLE 15-40
DEVELOPMENTAL PLAN INVESTMENT COSTS AND ANNUAL CHARGES
LOGAN RESERVOIR

Sector	Total Investment	Annual Charges
Industrial Expansion		
Industrial & Commercial	$73,900,000	$3,723,000
Public Facilities	2,900,000	146,000
Flood Protection	800,000	40,000
Residential	18,000,000	907,000
Recreation Visitation	814,000	41,000
Water Project Employment	376,000	19,000
	$96,790,000	$4,876,000

Note: The Developmental Plan investment costs reflect the entire estimate of costs related to industrial utilization of a 72-acre site at Athens and a 35-acre site at Logan. No attempt has been made to break down the total costs to assign only a portion to the Logan Dam and Reservoir Project on a system basis.

influx of new residents, it was considered that certain additional public facilities and residential developments would be required in the vicinity of Athens. The methodology for determining these investments was based on the Salyersville-Royalton Pilot Study. Hospital and higher education facilities were considered excellent because of Ohio University and a new hospital under construction. It was estimated that additional elementary and secondary school facilities, recreation facilities, water and sewage facilities, transportation facilities, and fire protection would be required. The total additional public investment at Athens was estimated to be $1,600,000. Of the total of 770 imported employees, it was estimated that 80 percent, or 620 employees would purchase homes. The additional residential investment at Athens was estimated to be $12,400,000.

It was estimated that 347 (25% x 1,386) new employees would be added to the regional labor force and be relocated in the vicinity of Logan, because of the development of the industrial site. Additional public facilities, including hospital and clinic, primary and secondary schools,

recreation, water supply and sewage, city streets, and fire protection would be required to accommodate the new employees and their families. The total public investment at Logan was estimated to be $1,300,000. It was estimated that 280 homes would be purchased by the new employees, representing an investment of $5,600,000.

Annual charge for the public and residential development were computed using a private interest rate of five percent, although it is acknowledged that some public facilities could be partially funded from Federal grants. It was assumed that all public and residential facilities would be completed in a five year period beginning with the construction of the industrial facilities in 1980. The total investments and annual charges for these investments at both sites are summarized in Table 15-40.

Certain additional flood control measures are necessary at each potential industrial site, after considering the reductions effected by Logan Reservoir and the local protection projects, to secure a flood protection level of once in 100 years. The additional protective measures are summarized as follows: Athens Site - levees at the upstream and downstream ends of the site to connect the B & O Railroad embankment to high ground, highway opening with gate closure in the downstream levee which crosses U. S. Highway 50, an impervious blanket on the railroad embankment to prevent seepage into the site, and a pumping facility to remove interior drainage from approximately 400 acres during periods of flooding; Logan Site - Impervious layer along the top and side of the existing Oldtown Creek Dike to obtain uniform level of protection and prevent seepage, stone protection along the outside of the dike to reduce bank erosion, an impervious blanket along the C & O Railroad embankment to which the dike and the new highway 328 embankment connect, and a small pumping station to remove interior storm drainage. The investment for the flood protection measures at both sites was computed assuming 50 percent replacement at the end of 25 years and 100 percent replacement at the end of 50 years. The total investment and the average annual costs, using a private interest rate of five percent, are included in Table 15-40.

Expenditures made by visitors who utilize the project recreation facilities create a demand for goods and services. This demand would induce private investment in additional commercial facilities providing food, lodging, etc., for the recreationists. This private investment within the Appalachian Region has been evaluated and included as a developmental cost. The investment costs were computed utilizing a methodology developed in the Salyersville-Royalton Area Pilot Project. Estimates of the local expenditure made by visitors to the reservoir recreation facilities were calculated using the projected average annual visitation and the estimated expenditures per visitor. The general recreation visitation was assumed to follow an accelerated growth pattern, based on actual visitation to water related recreation facilities similar to those proposed for Logan Reservoir. This pattern

of visitation is estimated to reach 50 percent of the ultimate at the third year and to continue at an accelerated rate, attaining the ultimate at the 100th year. All the estimated visitation to the nature area plus those engaging in fish and wildlife activities was considered to occur initially. From this pattern of attendance a total annual visitation expenditure was obtained by applying the average annual equivalent factor (.7622) to the estimated ultimate annual expenditure. It was estimated that 35 percent of the visitor expenditures would result in Appalachia. It was assumed that the expenditures in Appalachia would result in sales to commercial establishments. Additional sales would result due to the cycle of respending of the initial expenditures. Therefore, the average regional multiplier was applied to the visitor expenditures to determine the total regional sales impact. The average sales per square foot of commercial sales area was assumed to be $60. Applying this value to the total sales within the Appalachian Region, a required area of sales facilities was calculated. Using an average investment cost of $20 per square foot of building area (See footnote, Table 15-38) the total investment required for the commercial facilities was determined. Approximately 70 percent of the commercial investment was assumed to occur within the first five years of the recreation facility operation, with additional commercial investments being added as the visitation increases. The commercial investment was considered to be 50 percent buildings with 50 year useful life and 50 percent equipment with 25 year useful life. The total private recreation oriented commercial investment, including replacements, and the average annual commercial cost, assuming an interest rate of five percent and 100 year economic life are included in Table 15-40.

Wages earned by workers from direct employment on water project construction and operation, plus the wages produced by the respending cycle will create a demand for additional goods and services within the region. The total wages from project construction, including Government supervision and inspection personnel, were assumed to be earned in a four-year construction period with the wages to be expended uniformly during this period. The Operation and Maintenance wage expenditures were considered to be dispersed over the entire project life. An average wage expenditure was determined during the four-year period based on construction wage expenditures only, and it was assumed that 40 percent of these expenditures would result in sales to establishments within the Appalachian region. For purposes of this study, it was assumed that the existing commercial facilities would accommodate 50 percent of the demand for goods and services within the region. Commercial facilities to accommodate the remaining 50 percent of the annual sales were calculated and included as a developmental cost. These facilities to be provided during initial project construction would more than supply the needs demanded by the annual project Operation and Maintenance plus the future recreation construction and also would supply some of the demands of the recreation visitors. The actual investment was determined in a manner similar to that for the

recreation expenditures, by assuming a sales per square foot value to determine the area, and cost per square foot to determine the total investment. The facilities were assumed to be 50 percent buildings and 50 percent equipment with useful lives of 50 and 25 years respectively. The total investment, plus replacements, and the average annual charges at a five percent interest rate, are presented in Table 15-40.

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SECTION VI - BENEFITS

22. SUMMARY

The selected plan of development for the Logan Dam and Reservoir project would provide tangible benefits which can be classified as either user benefits or expansion benefits. Various portions of both of these categories would be ascribable to either the National economic account or the regional economic account. Other portions would be ascribed to both accounts. The remaining paragraphs in this section discuss the anticipated benefits and the procedures and techniques used to measure them. Table 15-41 summarizes the benefits.

23. USER BENEFITS

Flood control

Flood flow reductions. Logan Reservoir would effect flood flow reductions along both the Hocking River and the Ohio River. At Athens, Nelsonville, Logan and Rockbridge, further protection against flood flows would be afforded by the local protection projects. Table 15-42 gives the effects of the various combinations of Logan Reservoir and the local protection projects on floods of varying frequencies of occurrence at Rockbridge, Logan, Nelsonville and Athens. The tables incorporate statistical data analyzed prior to the flood in May 1968, the largest recorded flood at Athens since establishment of the gaging station there in 1915. The occurrence of this flood emphasizes the seriousness and chronic nature of flooding on the Hocking River. Average annual damages prevented by any proposed project could be expected to increase as a result of this flood. Consideration of the effectiveness of proposed improvements and specifically Logan Reservoir, should focus on average annual damages prevented. The reduction in flood stages can be misleading. For example, reduction of a 100-year frequency flood by 3.5 feet at Athens would prevent about $7,627,000 in damages (under present conditions), whereas the reduction of a 34-year frequency flood by 4.1 feet would prevent about $1,200,000 in damages. This relationship reflects the configuration of the valley cross-section and the relative position of damageable improvements on this cross-section. At Athens, damages are initially incurred as the stage reaches 16.0 on the Mill Street gage. The damages increase slowly as the stage increases to about 18 feet. Within the next seven feet, damages occur at an accelerated rate and would exceed $1,000,000, under present conditions, at a stage of 25 feet.

TABLE 15-41

AVERAGE ANNUAL BENEFITS FOR THE SELECTED PLAN OF DEVELOPMENT

Category and Class of benefits	Annual Benefits ($1,000)					
	National account only	Regional account only	Common to both accounts	Total National	Total Regional	Total comb. accounts
User Benefits						
Flood control	42.5	-	358.1	400.6	358.1	400.6
Water supply	164.6	-	0	164.6	0	164.6
Water quality control	-	-	73.9	73.9	73.9	73.9
Recreation	1,352.6	-	728.3	2,080.9	728.3	2,080.9
Nature Area	-	-	360.0	360.0	360.0	360.0
Total user benefits	1,559.7	-	1,520.3	3,080.0	1,520.3	3,080.0
Expansion benefits						
Redevelopment	-	180.5	78.7	78.7	259.2	259.2
Development	-	7,551.2	1,963.8	1,963.8	9,515.0	9,515.0
Total expansion benefits		7,731.7	2,042.5	2,042.5	9,774.2	9,774.2
Total benefits	1,559.7	7,731.7	3,562.8	5,122.5	11,294.5	12,854.2

TABLE 15-42

EFFECTS OF PROJECTS ON FLOODS
OF VARIOUS FREQUENCIES

Frequency	Reduction in feet		
	By Logan Reservoir	By Local Protection Project	By both Logan Reservoir & Local Protection Project
At Rockbridge			
1964 flood (35 year)	1.1	0.4	1.5
5 year	1.1	0.4	1.5
20 year	1.0	0.5	1.5
100 year	1.6	0.6	2.2
At Logan 1/			
1964 flood (34 year)	0.8	2.0	2.8
5 year	0.4	2.3	2.7
20 year	0.7	2.0	2.7
100 year	1.0	2.2	3.2
At Nelsonville			
1964 flood (34 year)	0.7	2.1	2.8
5 year	0.7	2.7	3.4
20 year	0.7	2.2	2.9
100 year	0.9	1.7	2.6
At Athens			
1964 flood (34 year)	0.8	3.3	4.1
5 year	0.7	4.4	5.1
20 year	0.8	3.8	4.6
100 year	0.8	2.7	3.5

1/ At State Route 93 bridge (Mulberry Street)

Flood damages prevented. The average annual flood damages prevented along the Ohio River by the potential Logan Reservoir would amount to $50,600 on July 1968 price levels and level of development. Table 15-43 shows the damages that would be prevented along the Hocking River, by reaches. A summary of Hocking River damages, that would be prevented by Logan Reservoir and the local protection projects at Rockbridge, Logan, Nelsonville and Athens is given in Table 15-44. Residual damages, after the system of Logan Reservoir and the local protection projects is operable, would amount to $214,500 for the entire Hocking River flood plain, or approximately 27 percent of the total average annual damages.

TABLE 15-43

AVERAGE ANNUAL HOCKING RIVER FLOOD
DAMAGES PREVENTED BY LOGAN RESERVOIR

(July 1968 price levels and
level of development)

IMPROVEMENTS	Damages Prevented	
	First Place	System
Rockbridge	$ 5,300	$ 4,600
Logan	34,600	24,200
Nelsonville	16,600	13,900
Athens	108,300	29,600
Enterprise	220	220
Enterprise to Logan	2,320	2,320
Logan to Nelsonville	820	820
Doanville	820	820
Doanville to Chauncey	370	370
Chauncey	1,400	1,400
Guysville to Athens	1,130	1,130
Guysville	70	70
Total, Improvements	$ 171,950	$ 79,450
CROPS		
Clear Creek to Scott Creek	$ 730	$ 730
Scott Creek to Monday Creek	6,000	6,000
Monday Creek to Sunday Creek	480	480
Sunday Creek to Guysville	1,050	1,050
Total, Crops	$ 8,260	8,260
OTHER DAMAGES PREVENTED 1/	14,100	14,100
TOTAL DAMAGES PREVENTED	$ 194,310	$101,810

1/ Includes special categories subsequently discussed.

TABLE 15-44

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED
LOGAN RESERVOIR AND LOCAL PROTECTION PROJECTS
(July 1968 price levels and level of development)

	Logan Reservoir			Local Protection Projects		
	First	Last	System	First	Last	System
Rockbridge	$ 5,300	$ 4,300	$ 4,600	$ 2,400	$ 1,400	$ 2,100
Logan	34,600	10,100	24,200	45,800	21,300	31,700
Nelsonville	16,600	7,300	13,900	40,000	30,700	33,400
Athens	108,300	23,900	29,600	417,200	332,800	411,500

Future damages prevented determination. To determine the basic rate of future growth in residential damages for general application throughout the Hocking River flood plain, projections were made of the number of households within the flood plain, and of the damages per household for a given degree of flooding. The product of these two variables provided the level of damages which could be anticipated in a future recurrence of a given flood. The projections were made only for fifty years due to limitations of available data.

There were no comprehensive flood damage surveys previous to 1962 to establish a damage trend. Therefore, the projection of damages per household was accomplished by determining the growth rate in personal consumption expenditures on furniture, household equipment, and housing. The increase in damage per house is considered to be directly related to the growth in these personal consumption expenditures. This rate was found to be 3.83 percent compounded annually between 1947 and 1959. Through regression analysis, consumption expenditures were projected at a dampened rate of 3.13 percent compounded annually between 1970 and 2020.

The projected increase in damages which would be expected between 1970 and 2020 represents a compound growth rate of 3.19 percent per year. Since estimating benefits for the purpose of this report requires a determination of the prospective growth of damages for project lives of 100 years, it was considered that a straight-line rate equivalent to the 3.19 percent compound rate until 2020, extended over the remainder of the economic life of each project, would be a more reasonable basis for estimating future damages. The resulting straight-line rate (which was derived through applicable average annual equivalent formulas) was 4.8 percent.

There are several factors which indicate that the 4.8 percent rate may be excessive. The method employed in its derivation assumes local growth in personal consumption expenditures to be directly related to Gross National Product. Both employment and population projections were found to be at a rate substantially less than those for the Nation.

In view of these disparities, it was considered advisable to adopt a reduced growth rate for general application to residential damages. Therefore, a rate of 4.0 percent straight-line was selected as the basic residential damage growth rate. In many urban damage reaches, the availability of desirable land for development is limited. If the 4.0 percent rate is to be realized, as projected, the growth must come in the relatively undeveloped reaches at a rate greater than 4.0 percent.

Therefore, the applicable rates for individual local reaches were selected on the basis of the quantity of land available for development with the objective of obtaining a gross growth rate throughout the valley of 4.0 percent straight-line.

The main part of Logan, on the left descending bank, has limited room for expansion. On an areal basis, there would be sufficient room for growth at a rate of about 3.0 percent straight-line over the life of the project. The residential areas within the flood plain are relatively old and considerable replacement is certain. In many residential areas adjacent to commercial and industrial development, houses will be replaced by large and valuable commercial and industrial structures. A limited growth rate of 3.5 percent straight-line is considered appropriate. The area downstream and east of Logan contains the greatest amount of available land for future development at Logan. More industry will undoubtedly locate in the flood plain with the knowledge that some flood protection will be afforded to the area by the proposed projects. There are about 150 acres of flood plain in this location within the limits of the March 1964 flood. About 28 percent (42 acres) of this area is now developed. This acreage includes room for expansion of existing facilities. It is anticipated that about 50 percent of the remaining area (50 acres) will be developed eventually by industrial firms. Assuming expansion of existing facilities to at least double, the remaining acreage could accommodate a growth rate of about 5.0 percent straight-line over the life of the project.

The entire reach of Nelsonville which would be protected by the proposed channel improvement project has sufficient undeveloped land to allow about a 2.5 percent straight-line growth over the life of the project. Assuming new development and replacement structures to be of higher value than existing development, a rate of 3.0 percent straight-line was adopted.

The institutional development at Athens has been substantial and is expected to continue into the near future. In the Hocking River Survey Report of January 1965, a straight-line growth rate of 7.0 percent was adopted for application to institutional damages up to year 1970, and it was believed to be conservatively low, both with respect to time and rate. The University's building plans indicate that the straight-line growth rate of 7.0 percent should be adopted for application to institutional damages up to year 1978. The projected basin rate of 4.0 percent was applied for growth thereafter.

The projected basin straight-line growth rate of 4.0 percent was adopted for the non-institutional development at Athens. There are 1,120 acres of flood plain within the limits of the 1964 flood at Athens. Only about 20 percent (220 acres) of this area is presently developed. Of 870 acres proposed for ultimate non-institutional development, only 160 acres are now developed. On strictly an areal basis, only about one-half of the undeveloped area set aside for non-institional development would be necessary to support the 4.0 straight-line rate for a period of 50 years.

The total area of potential industrial sites available in Athens and Hocking Counties would amount to 1,090 acres. On strictly an areal basis, this would allow a straight-line increase in industrial damages of 4.0 percent, since nearly all of these lands are within the Hocking River flood plain. Land filling and flood proofing would tend to off-

set the increase in damages due to the increased capital intensiveness of future industrial development. Since availability of land indicates that industrial damages would increase at a prospective rate of 4.0 percent straight-line, and manufacturing employment projections indicate a minimum increase of 3.6 percent straight-line, a rate of 4.0 percent straight-line was adopted for application to industrial damages prevented.

Flood control benefits. Average annual flood control benefits were computed by adjusting the average annual damages prevented to reflect the anticipated future growth in the affected areas. The Athens Local Protection Project was authorized on the basis of the project being economically justified when analyzed as a part of a system including the local project and the Logan Reservoir. The benefits claimed for the local project in its authorizing document were those obtained from the system analysis. The benefits attributable to Logan Reservoir shown herein have been computed on the same basis. Table 15-45 shows the flood control benefits for Logan Reservoir and the local protection projects.

TABLE 15-45

SUMMARY OF FLOOD CONTROL BENEFITS

(July 1968 price levels and level of development)

	Logan Reservoir		Local Protection Projects	
	First	System	First	System
Rockbridge	$ 9,400	$ 8,100	$ 3,600	$ 3,200
Logan	106,400	73,600	106,400	73,000
Nelsonville	37,700	31,400	72,200	60,100
Athens	295,800	80,800	837,000	825,600
Hocking River (Remainder)	31,400	31,400	-	-
Ohio River	129,500	129,500	-	-
Other Benefits 1/	45,800	45,800	-	-
Total	$656,000	$400,600	$1,019,200	$961,900

1/ Includes special categories subsequently discussed.

Average annual flood damages prevented and flood control benefits falling into special categories that were previously ignored because of difficulties encountered in estimating probable monetary values are identified and evaluated. These categories are average annual savings on certain items including railroad maintenance costs, highway detours and outages, loss of wages as a result of lack of access and clean up costs over and above what is normally included in damage surveys.

It is recognized that other inconveniences will occur as a result of floods that are difficult to evaluate monetarily. For instance, it is becoming more and more difficult for home owners to obtain loans for the replacement of furnishings which are permanently damaged by floods. Although preliminary evaluations indicate that increased interest rates do not significantly increase the total average annual expense by the home owners for this purpose, it is obvious that it does present problems for the more unfortunate families which are most difficult to farily evaluate.

The interruption of utilities including telephones, electric, gas, water and sewage lines have not been evaluated in a comprehensive scale but are considered significant. Other inconveniences have been particularly acute on the Ohio University campus at Athens in the floods of 1963 and 1964 but earlier warnings and an increased awareness of the problems have somewhat devaluated this worth. This was evident during the flood of May 1968. Although some loss of school time actually occurs, the students are not deprived of board and room so that major school expense losses are not realized.

Recreation benefits. Recreation benefits have been identified and claimed for the use of facilities to be provided for general recreation, fish and wildlife recreation, and the nature area. Recreation visitation and benefits were derived through the joint efforts of the Corps of Engineers, Ohio Department of Natural Resources, the U.S. Fish and Wildlife Service, and the Bureau of Outdoor Recreation. The ultimate project visitation, including all categories, is expected to be 2,816,000 annually, and would be reached at the end of the economic life of the project. The annual visitation in the third year after project construction should reach approximately 50 percent of the ultimate visitation figure. Recreation benefit values were derived using the standards for Senate Document 97 (87th Congress, second session). Annual recreation benefits total $2,440,900, and are summarized in Table 15-46.

Water supply and water quality control benefits. Water supply and water quality control benefits were based on the cost of providing an alternate source in the absence of the proposed Logan Reservoir. These costs, as derived by the FWPCA, reflected the increase in demand which would take place over the next 100 years. The required water supply quantities for Lancaster and the required releases for water quality control are discussed in Section II. The reservoir storages required to meet these needs are discussed in Section III. Provisions of the alternate source would be made in accordance with increases in demand. The alternative for water supply for Lancaster would be further development of its well field which would require expensive treatment because of the extreme hardness of the water. Water supply from the reservoir would eliminate the need for softening. The additional ground water treatment costs would be the alternative costs to be claimed as the water supply benefits. The average annual value of providing storage for water quality control was based on the cost of providing two smaller single purpose alternative reservoirs on tributaries of Clear Creek. The total average annual benefits thus derived for water supply and water quality control would be $164,600 and $73,900, respectively.

TABLE 15-46

LOGAN RESERVOIR
SUMMARY OF RECREATION VISITATION AND BENEFITS

	Initial[1/]	Future	Total
VISITATION			
General Recreation	1,326,000	1,326,000	2,652,000
Fishing			
Impoundment	30,850	-	30,850
Tailwater	9,000	-	9,000
Subtotal, Fishing	39,850		39,850
Wildlife			
Waterfowl hunting	1,100	-	1,100
Wildlife management unit	3,400	-	3,400
Subtotal, Wildlife	4,500		4,500
Total, Fishing and Wildlife	44,350		44,350
Nature Area	120,000		120,000
TOTAL, RECREATION VISITATION	1,490,350	1,326,600	2,816,350
BENEFITS			
General Recreation			$2,031,400[2/]
Fishing			
Impoundment			30,850
Tailwater			18,000
Subtotal, Fishing			$ 48,850
Wildlife			
Waterfowl hunting			3,300
Wildlife management unit			7,300
Subtotal, Wildlife			$ 10,600
Total, Fishing and Wildlife (rounded)			$ 59,500
Nature Area			$ 360,000
TOTAL RECREATION BENEFITS			$2,440,900

1/ Attendance level at end of third year of project life.
2/ General recreation annual benefits = total visitation (2,652,000)X$1.00 visitor day X average annual equivalent factor (0.7622) = $2,021,400

The benefits ascribed to these purposes do not reflect additional benefits which would be derived from assuring adequate water supplies for the valley of the Hocking River below Lancaster. The FWPCA concluded from its studies that return flows from the water supplied to Lancaster, in conjunction with natural and regulated flows would assure adequate water supplies for the communities that are now located or wish to locate in the Hocking River Valley. A detailed analysis of the water supply and water quality control problems is contained in the FWPCA report which was included in the Interim Survey Report on the Hocking River Basin, Ohio, dated 29 January 1965 (House Document No. 287).

24. EXPANSION BENEFITS

Expansion benefits are divided into two categories, redevelopment and development. Redevelopment benefits consist of wages earned by persons employed directly in the construction, operation and maintenance of the water resource project. Developmental benefits result from wage payments made to persons within the region not directly associated with the project construction or operation, but whose employment results from the economic activity induced by the water project development.

Redevelopment benefits. Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor wages earned in the construction, operation and maintenance of the water resource projects and spent within the region. Benefits credited to the National account are the wages earned by workers in the region who would otherwise be unemployed or underemployed in the absence of the water project construction. Redevelopment wage benefits to the project result from four areas of employment - water resource plan construction, dam and reservoir operation and maintenance, recreation facilities operation and maintenance, and nature area operation and maintenance. To calculate redevelopment benefits it is necessary to determine the portion of the total construction, operation and maintenance costs that result in wages. For this evaluation labor wages were estimated to be 25 percent of the construction cost, less lands and damages, permanent operating equipment, engineering and design and supervision and administration. Labor wage portions of the operation and maintenance costs were estimated to be 50, 40, and 67 percent for dam and reservoir, recreation, and nature area, respectively. It was assumed that 80 percent of the workers on project construction, operation and maintenance would come from within a 25 mile commuting radius of the project, which comprises all or portions of six counties, four of which are within the Appalachian region. Most of the remaining workers would come from the Columbus area. From an analysis of the available labor force within these six counties it was estimated that 46 percent of the total wages would be earned by residents of Appalachia and would accrue as regional benefits to the project.

Benefits accruing to the National account include all wages earned by previously unemployed and underemployed persons in Appalachia who were all assumed to be unskilled and semi skilled. The percentages of unskilled and semi skilled workers for each source of project employment were estimated and these percentages were applied to the wage earnings within Appalachia to determine the benefits to the National account. It was assumed that the area would gradually approach full employment over a period of 20 years. Accordingly, redevelopment benefits resulting from operation and maintenance wages and accruing to the National account were discounted to reflect this anticipated full employment condition.

Table 15-47 summarizes the annual redevelopment benefits creditable to the National and regional accounts.

TABLE 15-47

REDEVELOPMENT BENEFITS
LOGAN RESERVOIR

	Expenditure	Labor Costs	Annual Redevelopment Benefits: National account	Annual Redevelopment Benefits: Regional account
Construction				
Initial	$ 26,014,000	$6,500,000	$ 44,600	$ 82,000
Future	3,629,000	910,000	3,100	6,000
Subtotals	$ 29,643,000	$7,410,000	$ 47,700	$ 88,000
Annual Operation & Maintenance				
Dam & Reservoir	55,000	27,500	1,400	12,600
Recreation	424,100	170,000	27,800	131,000
Nature Area	89,400	60,000	1,800	27,600
Subtotals	$ 568,500	$ 257,500	$ 31,000	$ 171,200
Total Benefits			$ 78,700	$ 259,200

Developmental benefits. Developmental benefits are measured as increased income to persons within the region resulting from employment not directly associated with the project construction or operation, but stimulated by the presence of the water project. Such benefits evaluated in this report result from three sources: income earned by persons associated with the industrial expansion and related commercial and service development; income earned by persons employed in establishments providing goods and services to recreationists and tourists; and income earned by persons working in commercial and service establishments whose employment was induced by the spending of wages

earned in direct employment on project construction, operation and maintenance. Total developmental benefits assigned to Logan Reservoir are summarized in Table 15-48.

TABLE 15-48

DEVELOPMENTAL BENEFITS
LOGAN RESERVOIR

Resulting From:	Average Annual Benefits National Account	Average Annual Benefits Regional Account
Industrial and Associated Expansion	$1,860,000	$8,680,000
Recreation Visitor Expenditures	48,000	578,000
Water Project Employment (Multiplier effect)	55,000	257,000
Total Benefits	$1,963,000	$9,515,000

Industrial expansion. The development of industrial sites within the Hocking Basin will increase manufacturing employment directly and will indirectly increase employment in associated commercial and service facilities. Two potential industrial sites were evaluated for study purposes, one near Athens and one near Logan.

The site near Athens contains 72 acres and fully developed it was estimated to employ 1440 industrial workers. Utilizing data compiled from a land use survey*/ it was estimated that the annual wage per industrial employee would be $5733. The total wage benefits received from the 1440 industrial employees would be $8,244,000 annually. For this analysis it was assumed that these employees would be hired the first year following completion of the plant, and that the number of employees and their wages would remain constant during the 100 year economic life of the water project. In addition to the direct industrial employment, job opportunities in commercial and service facilities would increase because of the industrial expansion. The associated employment expansion was evaluated by using the county multiplier as developed in Recreation as an Industry. This multiplier concept indicates that 1.14 jobs in non-manufacturing would result for each new job in manufacturing, or a total of 1641 new jobs in commercial and service type employment. Assuming an annual wage of $4677, the total wages earned by the new commercial and service employees are $7,675,000 annually. It was assumed that all new employees, both manufacturing and non-manufacturing, would be 25 percent management, professional

*/ Based on results obtained by questionnaire by a University of Cincinnati student.

and skilled and that 75 percent would be semi skilled and unskilled. The semi skilled and unskilled positions would be filled by persons from the ranks of unemployed or under-employed within the local labor force. Because the potential plant site is located within Appalachia, the wages earned by these workers accrue as benefits to both the National and regional account. It was assumed that workers from outside the local area would be imported to fill the management, professional and skilled positions. The wages of these imported employees accrue as benefits to the regional account only. In consideration of other programs serving to reduce unemployment in addition to the Logan Reservoir Developmental Plan, the local wage benefits assigned to the National account were reduced to zero at the end of 20 years.

A reduction of flooding heights enabling the development of the industrial site was effected by Logan Reservoir acting in a system with the Athens Local Protection Project. Applying the ratio of the reductions effected by Logan Reservoir to that of the system, it was estimated that 40 percent of the industrial expansion benefits for the Athens site would be attributable to the Logan Reservoir Developmental Plan, therefore the benefits to both the National and regional accounts were assigned using this percentage.

The selected industrial site near Logan contains 35 acres and is the remaining portion of an industrial park development. This site, when fully utilized by industry, was estimated to employ 700 industrial workers. Using the average annual manufacturing wage of $6,117 as determined for Hocking County, the total annual wages were estimated to be $4,232,000. The considereations for the rate of employment and wages during the 100 year economic life were the same as for the Athens site. The associated commercial and service employment expansion was evaluated using the county multiplier concept. The Nathan report indicated that .98 non-manufacturing jobs would result for each new job in manufacturing, or a total of 686 additional jobs in commercial and service enterprises. Using an average non-manufacturing wage of $4,726 annually, the total annual wage benefits from commercial and service employees were estimated to be $7,296,000. Wages earned by unemployed workers from the local area within Appalachia, assumed to be 75 percent, accrue as benefits to the National account. Wages from the remaining 25 percent, assumed to be reported from outside the region, would be credited to the regional account only. Wage benefits to the National account were discounted to reflect a condition of full employment at the end of 20 years. The system of Logan Reservoir and the Logan Local Protection Project would reduce flooding heights in the vicinity of Logan, permitting the development of the potential industrial site. Based on the ratio of the reduction for Logan Reservoir to that of the entire system, it was estimated that 30 percent of the industrial expansion benefits for the Logan site would be attributable to the project developmental plan. Total developmental

benefits resulting from industrial exapnsion are $1,860,000 for the National Account and $8,680,000 for the Regional Account.

Recreation expenditures. Additional regional employment opportunities will result because of commercial investment induced by the recreationist and tourist expenditures. The wages earned by persons employed in these commercial establishments have been evaluated in this study and are designated as developmental benefits. It is estimated that ultimately 2,816,000 persons will annually visit the recreation facilities at Logan Reservoir. A detailed breakdown of the origin of visitors and the ultimate annual visitor expenditure is presented in Table 15-49.

TABLE 15-49

RECREATION VISITOR EXPENDITURES

Ultimate Annual Visitation	Distance Traveled (Mi.)	Percent of Total Visitation	Daily Expenditures Per Visitor	Ultimate Annual Expenditures
2,816,000	0-25	25	$ .50	$ 352,000
2,816,000	26-50	40	1.00	1,126,000
2,816,000	51-75	20	2.00	1,126,000
	More than 76	15	4.00	1,690,000
	Ultimate Annual Visitor Expenditures =			$4,294,000

Forty percent of the visitation was estimated to originate from within a 50-mile radius primarily because of the promimity to the Columbus Metropolitan area. The origin of all visitors was based on the estimated population and the availability of other water oriented recreation facilities. Study report No. 24 of the Outdoor Recreation Resources Review Commission indicates that 24 percent of the recreation visitor expenditures accrue as wages and salaries to individuals. For this study it was estimated that 24 percent of these expenditures would result in wage and salaries to persons whose employment was generated by the presence of the water project. The Logan Dam site at stream mile 3.1 is located within Appalachia, but the majority of the recreation development is outside the Appalachian boundary. Recreationists and tourists attracted to the Logan Reservoir development will come from both inside and outside Appalachia. Giving consideration to the origin, route of travel to reach the project and types and locations of facilities to be utilized by the visitors, it was estimated that 35 percent of these expenditures would be made within Appalachia. Because of the respending cycle of the basic wages resulting from the visitor expenditure, additional income would result to workers within the region. This additional economic impact was evaluated by utilizing county multiplier as derived in the Nathan report. An average

regional multiplier of 2.0 was determined for the six-county area, and this was applied to the basic wages resulting from the visitor expenditures to obtain the secondary effect. It was assumed that 75 percent of the multiplier effect would result in wages, with the remainder going to profit. To obtain an average annual wage benefits, an average annual equivalent benefit factor was applied to the ultimate annual visitor expenditure within Appalachia. The wage totals obtained constitute the developmental benefits creditable to the regional account. The wages earned by persons previously unemployed or under-employed, assumed to be 44 percent of the total, accrue as benefits to the National account. It was assumed that the region would gradually approach full employment over a 20-year period, and accordingly, benefits to the National account were discounted to reflect this condition. The annual wage benefits resulting from recreation visitor expenditures are $48,000 and $578,000 for the National and Regional Accounts, respectively.

Water project employment. Developmental benefits accrue to the water project plan because of the respending of the wages earned by direct employment on project construction and operation (redevelopment benefits). As previously discussed for redevelopment benefits, these wages stem from construction of the dam and reservoir, recreation facilities and nature area facilities and the operation and maintenance of these project features. The economic impact resulting from the respending of the basic wages was evaluated using the county multiplier concept. From the Nathan report an average regional multiplier of 2.0 was calculated, and this was applied to the portion of the basic wages spent within the region. Analyzing the employment and unemployment within the six-county region, it was estimated that about 40 percent of the wages would be spent within Appalachia. Wage benefits thus determined accrue to the regional account. It was estimated that 75 percent of the multiplier effect would result in wages, the remainder going to profit. It was estimated that 44 percent of the project workers would be previously unemployed or under-employed, and the wages earned by these workers would accrue to the National account. Benefits to the National account from operation and maintenance wages were discounted over a 20-year period to reflect the anticipated full employment condition at that time. The average annual developmental benefits from water project employment are $55,000 and $257,000 for the National account and Regional account, respectively.

Additional developmental benefits. The new investments associated with the project developmental plan will be a source of tax revenue for the cities and counties within the region. Although it is recognized that these tax revenues constitute tangible benefits to the Appalachian region, they were not evaluated for this study.

In addition to wages and salaries resulting from commercial investments, benefits in the form of profit to the private investors

would accrue to the region. No monetary value has been assigned to the profits that would result from these private investments in commercial and service establishments.

SECTION VII - ECONOMIC ANALYSIS

25. ECONOMIC DATA

Project costs. Annual economic charges were computed utilizing data developed in the cost estimates presented in Section V of this chapter. These charges differ slightly from the financial annual charges computed for the Logan Reservoir. The difference results from allowing for loss of land productivity which is based on 5 percent annual net income on lands taken for the project. A summary of costs for Logan Reservoir is shown in Table 15-50.

TABLE 15-50

SUMMARY OF COSTS
(July 1968 Prices)

CONSTRUCTION COST 1/	
Lands and damages	$ 8,850,000
Relocations	4,370,000
Reservoir	850,000
Dam and appurtenances	9,506,000
Recreation 2/	18,221,000
Nature Area	2,126,000
Permanent operating equipment	218,000
TOTAL	$ 44,141,000
ANNUAL CHARGES	
Interest at 3-1/4%	$ 1,451,200
Amortization in 100 years	61,500
Maintenance and operation	568,500
Major replacements	131,100
Subtotal, financial charges	$ 2,212,300
Land productivity loss	86,800
TOTAL WATER RESOURCES PROJECT, ECONOMIC CHARGES	$ 2,299,100
Development plan investment costs	4,876,000
TOTAL, PUBLIC AND PRIVATE ANNUAL CHARGES	$ 7,175,100

1/ Cost shown includes cost of engineering, design, supervision and administration.
2/ Of this amount $13,732,000 is for initial facilities and $4,489,000 is for future facilities.

Development plan investment costs. Annual charges for this feature amount to $4,876,000, based on a total public investment of $96,790,000. Discussion concerning procedures used to develop the estimated cost of this investment is presented in paragraph 20.

Project and development plan benefits. Annual economic benefits developed and discussed in Section VI are summarized in Table 15-51 for the National and regional accounts. The total impact of the project would be reflected in the combined national and regional effects which would derive an average of $12,854,200 benefits annually.

TABLE 15-51

SUMMARY OF ANNUAL BENEFITS
FOR LOGAN RESERVOIR 1/
($1,000)

Type of Benefit	National	Regional
User	3,080.0	1,520.3
Redevelopment	78.7	259.2
User plus Redevelopment	3,158.7	1,779.5
Development	1,963.8	9,515.0
Expansion (Redevelopment plus Development)	2,042.5	9,774.2
TOTAL BENEFITS	5,122.5	11,294.5

1/ For more detailed breakdown and discussion of annual benefits see Section V.

Indices of performance. One index of performance can be evaluated by reliance on the conventional ratio of benefits to costs generally developed for water resource projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water projects (redevelopment benefits). The denominator is the annual economic cost of the water projects. Such an index, computed below, expresses the minimum index of performance in regard to national income augmentation.

$$\frac{3,158,700}{2,299,100} = 1.4$$

Another index of performance gives a relative measure of the contribution that the Logan development would make to the objective of employment expansion. The numerator consists of increased wage payments for construction and operation of the water project plus wages and salaries and other income flows to the region generated by the industrial expansion, associated private investments, and recreational expenditures. The denominator is the annual cost, both

public and private, necessary to provide the expansion in employment opportunities.

$$\frac{9,774,200}{7,175,100} = 1.4$$

26. ALLOCATION OF COSTS

Costs of the Logan Reservoir project were allocated by the separable cost-remaining benefit method. Purposes among which costs were allocated include flood control, water supply, water quality control, recreation, nature area and regional economic expansion. Table 15-52 summarizes the construction expenditures, annual operation, maintenance and major replacement costs, total capital investment costs and annual charges. The allocation is given in Table 15-53. A sub-allocation of recreation costs are shown in Table 15-54.

Alternative costs. To provide an equitable basis for allocation of project costs to each purpose, the benefits for each purpose were limited to the cost of providing an alternative single-purpose project, where such alternative costs would be less than or equal to the estimated benefits. The alternative costs for the flood control function, as summarized in Table 15-52, were based on actual estimates of the cost of providing a single-purpose flood control project at the site selected for the multiple-purpose project.

The alternative costs for the recreation function were developed from state parks costs statistical data compiled by the Corps of Engineers. The determination of the alternative costs is discussed in detail in Section IV. Alternative costs for both water supply and water quality control were developed by the Federal Water Pollution Control Administration. The benefits and costs given in its report were discounted to 1970 and based on prices prevailing in July 1964. These estimates have been adjusted herein to reflect a 1978 completion date and escalated to reflect July 1968 prices.

Separable costs. These are the costs which are made necessary because a purpose is included in the multiple-purpose project. These costs are normally determined in the process of project formulation in considering the economic feasibility of including a purpose in a joint project. The separable cost is the minimum amount which should be considered for allocation to a given purpose. The separable cost for any specified purpose is determined by subtracting from the cost of the multiple-purpose project the cost of the most economical alternative project to obtain the same benefits for the other purposes with the specified purpose omitted as shown in Table 15-53. The costs for the alternate multiple-purpose projects omitting one purpose each are summarized in Table 15-52.

TABLE 15-52

ANALYSIS OF CONSTRUCTION, INVESTMENT AND ANNUAL COSTS
LOGAN DAM AND RESERVOIR PROJECT
($1,000)

Item	Multiple Purpose Reservoir							Alternate Single Purpose Projects					Multiple Purpose Project Less					
	Specific Use Lands & Facilities																	
	Regional Income Expansion	Nature Preserve	Water Quality	Recreation	Water Supply	Joint Use Costs	Total Costs	Flood Control	Water Supply	Water Quality	Recreation	Regional Income Expansion	Flood Control	Water Quality	Recreation	Water Supply	Nature Preserve	Regional Income Expansion
Construction First Cost																		
Lands and damages	$ -	$ -	$ -	$ 2,015.0	$ -	$ 6,835.0	$ 8,850.0	$ 3,863.0					$ 8,850.0	$ 8,850.0	$ 6,835.0	$ 8,850.0	$ 8,850.0	$ 8,850.0
Relocations	-	-	-	-	-	4,370.0	4,370.0	3,925.0					3,952.0	4,370.0	4,370.0	4,370.0	4,370.0	4,370.0
Reservoir & pool preparation	-	-	-	-	390.0	460.0	850.0	180.0					849.0	850.0	850.0	497.0	850.0	850.0
Dam & appurtenances	-	-	39.0	-	-	9,467.0	9,506.0	8,771.0					7,948.0	9,503.0	9,506.0	9,506.0	9,506.0	9,506.0
Recreation facilities	-	-	-	13,732.0	-	-	13,732.0	-					13,732.0	13,732.0	-	13,732.0	13,732.0	13,732.0
Nature Area	-	2,126.0	-	-	-	-	2,126.0	-					2,126.0	2,126.0	2,126.0	2,126.0	-	2,126.0
Permanent operating equipment	-	-	14.0	-	-	204.0	218.0	208.0					183.0	206.0	218.0	218.0	218.0	218.0
Total, initial	-	$2,126.0	$53.0	$15,747.0	$390.0	$21,336.0	$ 39,652.0	$16,947.0					$ 37,640.0	$ 39,637.0	$ 23,905.0	$ 39,299.0	$ 37,526.0	$39,652.0
Future recreation facilities	-	-	-	4,489.0	-	-	4,489.0	-					4,489.0	4,489.0	-	4,489.0	4,489.0	4,489.0
Total construction costs (Water Project)	$ -	$2,126.0	$53.0	$20,236.0	$390.0	$21,336.0	$ 44,141.0	$16,947.0					$ 42,129.0	$ 44,126.0	$ 23,905.0	$ 43,788.0	$ 42,015.0	$44,141.0
Development plan	96,790.0	-	-	-	-	-	96,790.0	-					96,790.0	96,790.0	96,790.0	96,790.0	96,790.0	-
Total, construction costs	$96,790.0	$2,126.0	$53.0	$20,236.0	$390.0	$21,336.0	$140,931.0	$16,947.0					$138,919.0	$140,916.0	$120,695.0	$140,578.0	$138,805.0	$44,141.0
Investment Costs																		
Initial construction costs	$ -	$2,126.0	$53.0	$15,747.0	$390.0	$21,336.0	$ 39,652.0	$16,947.0					$ 37,640.0	$ 39,637.0	$ 23,905.0	$ 39,299.0	$ 37,526.0	$39,652.0
Interest during construction	-	138.2	3.4	1,032.6	25.4	1,386.8	2,577.4	1,101.6					2,446.6	2,576.4	1,553.8	2,554.4	2,439.2	2,577.4
Investment cost, initial increment	-	2,264.2	56.4	16,770.6	415.4	22,722.8	42,229.4	18,048.6					40,086.6	42,213.4	25,458.8	41,853.4	39,965.2	42,229.4
Future recreation facilities	-	-	-	4,489.0	-	-	4,489.0	-					4,489.0	4,489.0	-	4,489.0	4,489.0	4,489.0
Development plan	96,790.0	-	-	-	-	-	96,790.0	-					96,790.0	96,790.0	96,790.0	96,790.0	96,790.0	-
Total, investment costs	$96,790.0	$2,264.2	$56.4	$21,259.6	$415.4	$22,722.8	$143,508.4	$18,048.6					$141,365.6	$143,492.4	$122,248.8	$143,132.4	$141,244.2	$46,718.4
Annual Financial Charges																		
Initial Increment																		
Interest & amortization	$4,876.0	$ 76.7	$1.9	$ 568.1	$14.1	$769.8	$6,306.6	$611.5					$6,234.1	$6,306.2	$5,738.5	$6,293.9	$6,229.9	$1,430.6
Operation & maintenance	-	89.4	5.0	280.4	-	50.0	424.8	50.0					414.8	419.8	144.4	424.8	335.4	424.8
Major replacement	-	15.1	0.2	97.7	-	2.0	115.0	2.0					114.3	114.8	17.3	115.0	99.9	115.0
Total, initial increment	$4,876.0	$181.2	$7.1	$ 946.2	$14.1	$821.8	$6,846.4	$663.5					$6,763.2	$6,439.8	$5,900.2	$6,833.7	$6,665.2	$1,970.4
Future Increment																		
Interest & amortization	-	-	-	82.1	-	-	82.1	-					82.1	82.1	-	82.1	82.1	82.1
Operation & maintenance	-	-	-	143.7	-	-	143.7	-					143.7	143.7	-	143.7	143.7	143.7
Major replacements	-	-	-	16.1	-	-	16.1	-					16.1	16.1	-	16.1	16.1	16.1
Total, future increment	-	-	-	241.9	-	-	241.9	-					241.9	241.9	-	241.9	241.9	241.9
Total, annual financial charges	$4,876.0	$181.2	$7.1	$1,188.1	$14.1	$821.8	$7,088.3 3/	$663.5	$164.6 1/	$73.9 1/	$1,685.2	$7,075.6	$7,005.1	$7,082.7	$5,900.2	$7,075.6	$6,907.1	$2,212.3

1/ Based on least expensive alternative as computed by FWPCA adjusted to reflect 1978 initial use and 3-1/4% interest rate.

2/ Amount computed based on statistical analysis of actual expenditures at similar developments.

3/ Does not include economic charge for net loss of land productivity of $86,800 annually. Total economic cost for project and associated investment would be $7,175,100 annually.

TABLE 15-53

ALLOCATION OF COSTS ($1,000)
LOGAN DAM AND RESERVOIR PROJECT

	Item	User Effects: Flood Control	User Effects: Recreation	User Effects: Water Supply	User Effects: Water Quality	Regional Expansion Effects	Nature Area	Total
1.	Benefits	400.6	2,080.9	164.6	73.9	9,774.2	360.0	12,854.2
2.	Alternative Costs	663.5	1,685.2	164.6	73.9	7,075.6	181.2	9,844.0
3.	Benefit limits	400.6	1,685.2	164.6	73.9	7,075.6	181.2	9,581.1
4.	Separable Costs	83.2	1,188.1	12.7	5.6	4,876.0	181.2	6,346.8
5.	Remaining Benefits	317.4	497.1	151.9	68.3	2,199.6	0.0	3,234.1
6.	Allocation of restricted joint costs							
	a. Remaining benefits	-	497.1	151.9	68.3	-	0	717.3
	b. Ratio	-	.693	.212	.095	-	0	1.000
	c. Allocated restricted costs	-	111.7	34.2	15.3	-	0	161.2 1/
7.	Separable plus allocated restricted costs	83.2	1,299.8	46.9	20.9	4,876.0	181.2	6,508.0
8.	Remaining benefits	317.4	385.4	117.7	53.0	2,199.6	0	3,073.1
9.	Ratio	.103	.125	.038-	.017-	.717	0	1.000
10.	Allocated joint costs 2/	59.8	72.5	22.0	9.9	416.1	0	580.3
11.	Total allocated financial costs	143.0	1,372.3	68.9	30.8	5,292.1	181.2	7,088.3
	ALLOCATION OF OPERATION, MAINTENANCE AND REPLACEMENT COSTS 3/							
12.	Separable OM&R Charges	10.7	537.9	0	5.2	0	104.5	658.3
13.	Allocated joint OM&R 2/	4.2	5.2	1.6	0.7	29.6	0	41.3
14.	Total allocated OM&R	14.9	543.1	1.6	5.9	29.6	104.5	699.6
	ALLOCATION OF INVESTMENT COSTS							
15.	Annual investment costs	128.1	829.2	67.3	24.9	5,262.5	76.7	6,388.7
16.	Capitalized investment costs 4/	3,780.6	24,480.1	1,986.2	734.9	108,124.0	2,264.2	141,443.9
17.	Adjustment for discount on future increment		2,064.5	-	-	-	-	2,064.5
18.	Total allocated investment costs	3,780.6	26,544.6	1,986.2	734.9	108,197.9	2,264.2	143,508.4
	ALLOCATION OF CONSTRUCTION COSTS							
19.	Investment in specific use lands & facilities	-	21,259.6	415.4	56.4	96,790.0	2,264.2	120,785.6
20.	Investment in joint use lands & facilities	3,780.6	5,285.0	1,570.8	678.5	11,407.9	0	22,722.8
21.	Interest on joint use lands and facilities	230.7	322.6	95.9	41.4	696.2	0	1,386.8
22.	Allocated construction costs of joint use lands & facilities	3,549.9	4,962.4	1,474.9	637.1	10,711.7	0	21,336.0
23.	Construction costs of specific use lands & facilities	-	20,236.0	390.0	53.0	96,790.0	2,126.0	119,595.0
24.	Total allocated construction costs	3,549.9	25,198.4	1,864.9	690.1	107,501.7	2,126.0	140,931.0
25.	Construction costs of future increment	-	4,489.0	-	-	-	-	4,489.0
26.	Construction costs of Development Plan	-	-	-	-	96,790.0	-	96,790.0
27.	Construction costs of water project (Initial)	3,549.9	20,709.4	1,864.9	690.1	10,711.7	2,126.0	39,652.0
28.	Total construction costs of water project	3,549.9	25,198.4	1,864.9	690.1	10,711.7	2,126.0	44,141.0

1/ Steps in determination of allocated restricted joint costs for recreation, water quality control and water supply.
(a) Derive separable costs in line 4 for all purposes in accordance with regular procedure - the difference between the cost of the multiple purpose project and the cost of the multiple purpose project with one purpose omitted.
(b) Subtract from the multiple purpose project the cost of the single purpose flood control project at the site.
(c) Subtract from remainder of (b) above the sum of separable costs allocated to recreation, water supply, water quality control, regional expansion effects and nature preserve. The remainder of this computation is the sum of the restricted joint costs ($161.2) that serve recreation, water quality control and water supply.
(d) The sum of the restricted joint costs are allocated in proportion to remaining benefits for the three purposes.

2/ In proportion to remaining benefits (line 8).

3/ There are no restricted joint O. M. & R. costs to be allocated.

4/ Flood control, water quality control, water supply and recreation costs are capitalized to present worth by (29.5129) X annual investment costs. Remainder of capital costs are allocated to Regional Economic Expansion effects.

TABLE 15-54

SUB-ALLOCATION OF GENERAL AND
FISH AND WILDLIFE RECREATION COSTS

CONSTRUCTION COSTS

(1)	Total allocated costs for combined purposes	$ 25,198,400
(2)	Total separable costs for combined purposes, equals total specific costs for combined purposes	20,236,000
(3)	Total joint costs for combined purposes (1)-(2)	4,962,400
(4)	Separable Cost (Specific cost) for General Recreation	19,796,100
(5)	Separable Cost (Specific cost) for Fish and Wildlife	439,900
(6)	Ratio general recreation benefits to combined benefits (2,021,400) + (2,080,900)	0.971
(7)	Joint costs allocated to General Recreation (3)x(6)	4,818,500
(8)	Ratio fish and wildlife benefits to combined benefits (59,500) + (2,080,900)	0.029
(9)	Joint costs allocated to Fish and Wildlife (3)x(8)	143,900
(10)	Total costs allocated to General Recreation (4)+(7)	24,614,600
(11)	Total costs allocated to Fish and Wildlife (5)+(9)	583,800

OPERATION, MAINTENANCE AND MAJOR REPLACEMENTS COSTS

(1)	Total allocated costs for combined purposes	$ 543,100
(2)	Total separable costs for combined purposes, equals total specific costs for combined purposes	537,900
(3)	Total joint costs for combined purposes (1)-(2)	5,200
(4)	Separable cost (Specific cost) for General Recreation	519,600 1/
(5)	Separable cost (Specific cost) for Fish and Wildlife	18,300
(6)	Ratio general recreation benefits to combined benefits	0.971
(7)	Joint costs allocated to General Recreation (3)x(6)	5,049
(8)	Ratio Fish and Wildlife benefits to combined benefits	0.029
(9)	Joint costs allocated to Fish and Wildlife (3)x(8)	151
(10)	Total costs allocated to General Recreation (4)+(7)	524,649
(11)	Total costs allocated to Fish and Wildlife (5)+(9)	18,451

1/ Based on $0.20 per visitor-day for O&M plus replacement costs from detailed estimates.

SECTION VIII - COST SHARING

27. APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

Water Supply. In accordance with the Water Supply Act of 1958, as amended, non-Federal interests have been apportioned all construction costs allocated to water supply, presently estimated to be $1,887,100. Local interests must also assume the annual operation, maintenance and major replacement costs allocated to water supply, estimated to be $1,600.

Recreation. The Federal Water Project Recreation Act of 1965 requires that non-Federal interests agree to administer project land and water areas for recreation and fish and wildlife enhancement and to bear not less than one-half the separable costs of the project allocated to those purposes and all separable costs for operation, maintenance and replacement. One-half of the allocated separable construction costs are estimated to be $9,898,000 and $220,000 for general recreation and fish and wildlife enhancement, respectively. Operation, maintenance and replacement costs are estimated to be $519,600 and $18,300 annually for general recreation and fish and wildlife enhancement, respectively. The remaining construction expenditures allocated to recreation are apportioned to the Federal Government.

Water quality control. Section 2 of Public Law 87-88, 87th Congress, first session, states that if the benefits attributed to water quality control are identified as widespread or national in scope, the costs of the water quality control features will be non-reimbursable. The U. S. Public Health Service, in their report dated January 1965, concluded that the benefits of water quality control storage are widespread in scope. Therefore, all costs allocated to water quality control have been apportioned to the Federal Government.

Flood control. All costs allocated to flood control have been apportioned to the Federal Government in accordance with the Flood Control Act of 1938.

Clear Creek Nature Area. Subsequent to completion of the special studies concerning preservation of ecological values in the Clear Creek Valley, the proposed project was expanded to include additional land acquisition, a nature interpretive center, and other educational and scientific facilities. The area downstream from the selected site to a point at which U. S. Route 33 crosses Clear Creek will be acquired for public ownership in order to mitigate damages to the scenic and scientific environment that would result from inundation of the valley upstream from the dam site and in order to insure preservation of the remaining portion of the valley by excluding undesirable environmental intrusions that would likely occur following project completion. This area would include Neotoma Valley to prevent urbanization and protect it against recreational crowds and development that would be stimulated by construction of the project. The cost of mitigation has been charged jointly to all project purposes. Those costs charged specifically to the Clear Creek Nature Area as a project purpose include only the costs for features of enhancement. As discussed previously, the mitigation cannot be achieved fully without at

least some portion of the facilities to be provided as enhancement. In view of the mutual dependency between mitigation and enhancement, the enhancement costs are not considered to be wholly reimbursable. In consonance with the cost-sharing philosophy of the Federal Water Project Recreation Act of 1965 (PL 89-72), one-half of the separable costs allocated to the Clear Creek Nature Area, presently estimated to be $1,063,000, and all of the allocated separable operation, maintenance, and major replacement costs presently estimated to be $104,500 annually, have been apportioned to non-Federal interests. The remaining construction expenditures allocated to the area are apportioned to the Federal Government.

If an alternative upstream site is selected for project development as a result of further study to be conducted during advanced planning of the project, it may be determined that a smaller part of the nature area costs (or possibly none) can be attributed to mitigation of ecological losses. If mitigation is deemed to be inappropriate, costs of the nature area then would be apportioned between Federal and non-Federal interests in accord with the guidelines contained in PL 89-72.

28. STATE AND LOCAL ASSURANCES

In re-evaluating the authorized Logan Reservoir project for size and scope to meet current and projected needs, it has been determined that sufficient storage would be available to provide a water supply of up to 24 million gallons per day. The modification of the project to include this purpose would not be incompatible with flood control, for which the project was originally authorized. Should this water supply storage be included in the project as a part of the detailed design studies, state or local interests must furnish formal assurances at the time of such studies that they will pay the costs allocated to water supply storage. At this time, it is considered that an indication of valid interest by a potential user is all that is necessary to permit further planning for the highest and best use of available storage at the Logan Reservoir site. Payment of first costs allocated to storage for current water supply use can be made by non-Federal interests during the construction phase of the project, or on an annual payment basis, as provided for by the Water Supply Act of 1958, as amended.

Also, state or local interests would be required to pay one-half of the separable construction costs allocated to recreation and all of the separable costs for operation, maintenance and major replacements for that function.

The Director of the Department of Natural Resources, State of Ohio, recognizing the identified needs for a high quality water supply source for Lancaster and other communities and areas along the Hocking River, and being extremely interested in recreational development and preservation of the natural environment, has indicated the State's intent to provide all necessary assurances required for the water supply, recreation, and nature area features of the reservoir. The Director's letter is included as Exhibit 15-28.

JAMES A. RHODES
GOVERNOR

FRED E. MORR
DIRECTOR

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
OHIO DEPARTMENTS BUILDING
COLUMBUS 43215

August 29, 1969

Colonel John C. H. Lee, Jr.
Director, Office of Appalachian Studies
U. S. Army Corps of Engineers
Post Office Box 1159
Cincinnati, Ohio 45201

Development of Water Resources in Appalachia -
Logan Dam and Reservoir Project

Dear Colonel Lee:

Reference is made to the draft report on the Logan Dam and Reservoir Project recently furnished for our review and comments. This report and especially the selected plan of development were carefully reviewed.

We have noted that the economically feasible plan of development consisting of the multiple-purpose Logan Dam and Reservoir Project and the Clear Creek Nature Preserve will provide flood damage reduction, municipal and industrial water supply, improvement of water quality, outdoor recreation, preservation of natural values, and fish and wildlife enhancement. This project, as formulated, will provide significant economic and social benefits to the Hocking River Basin, Hocking Hills Region, and the State of Ohio.

Under the authority granted the Director of the Department of Natural Resources in Section 1501.02, Ohio Revised Code, and acting as the designated representative of the Governor in matters of mutual interest to the Corps of Engineers and the State of Ohio, I concur with the selected plan of development. It will be the policy of the Department of Natural Resources under the provisions of the Federal Water Project Recreation Act to administer the project land and water areas, including the Clear Creek Nature Preserve, for recreation, conservation, and fish and wildlife enhancement; to bear one half the separable costs of the project allocated to these purposes; and to operate, maintain and make replacement of facilities.

In accordance with the Water Supply Act of 1958, as amended, the Department of Natural Resources will administer the water supply feature of the project and will bear all costs allocated to this purpose.

"We the undersigned are expressing herewith our opposition to

The Ohio Water Pollution Control Board will, under existing authority and policy, require the maximum degree of treatment of waste waters discharged into the waters of the basin below Logan Reservoir.

The State of Ohio will assume the leadership in taking such action as necessary to prevent diversion to other uses of any water quality storage provided in Logan Reservoir. The State will also use every means available to protect the channels of Clear Creek and the Hocking River downstream from Logan Reservoir from encroachment which would adversely affect operation of the project.

At such time as detailed planning is undertaken for the Logan Dam and Reservoir Project, the State of Ohio, acting for itself or on behalf of any interested political subdivision, reserves the right to recommend to and negotiate with the Corps of Engineers concerning modifications or additional project purposes which may be deemed mutually desirable.

I wish to compliment you and the staff for the preparation of what we consider to be an excellent product. The investigations were thorough and carefully done. This, together with the orderly arrangement of the report, facilitated our review.

Your cooperation with the Department of Natural Resources and with other agencies of the State of Ohio during the preparation of the Logan Reservoir Survey Report is appreciated.

Sincerely,

Fred E. Morr

FRED E. MORR
Director

FEM:bg

Sheet 2 of 2
Exhibit 15-28

SECTION IX - COORDINATION IN PLANNING

29. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture; Commerce; Interior; and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Huntington District of the Corps of Engineers or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

Many Federal agencies such as the U. S. Geological Survey, Environmental Science Services Administration, and the Office of Business Economics provided basic data for project planning, such as climatologic, streamflow, and economic records through regular publications or special reports. Other Federal agencies participated indirectly by assisting the state and local agencies and planning groups.

Several agencies made special studies as an aid in formulation and evaluation of the plan of development for Logan Reservoir. Reports of these agencies are included in the appropriate appendices to this report. The following paragraphs present recommendations or views of participating agencies, and actions taken.

Bureau of Outdoor Recreation. The Bureau of Outdoor Recreation (BOR) surveyed the recreation market area and determined that the demand for recreation opportunities, present and future, exceeds the capabilities of the recreation developments of the project area. The Bureau estimated that at ultimate level of outdoor recreation development, 1,100,000 recreation days annually would be expected within five years of project completion. Further studies, conducted by the Corps of Engineers have resulted in recreation development that would accommodate an ultimate visitation of 2,652,000 recreation days annually. In the Summary in Appendix F, the Bureau of Outdoor Recreation recommends further studies of alternatives to determine the best interest of outdoor recreation. Preliminary studies by the National Park Service indicate that significant ecological and natural science resource losses might occur if the project were constructed, and that detailed studies may confirm that an alternative site should be selected to prevent such losses.

National Park Service. The objectives of the National Park Service are: (a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values, (b) Improvement of land and water quality management, and (c) Consideration of structural and non-structural measures, beneficial flow regulation and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966, requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the Corps of Engineers. These studies will be requested when advanced engineering and design for the project is initiated.

The National Park Service provided a report on the "Archeological, Historical and Natural Science Values of the proposed Logan Reservoir, Hocking and Fairfield Counties, Ohio." The report concludes that additional archeological survey would be unnecessary but that archeological testing of five rock shelters to be affected would be of prime importance. Regarding historical values, the report concludes that no significant historical remains survive in the Clear Creek project area with the possible exception of two covered bridges for which preservation should be considered. The plan of development provides for relocating one of the two bridges to the Nature Area for use as a foot bridge where one of the nature trails crosses Clear Creek. The other bridge is in such poor condition that relocation may not be practicable. The assessment of the natural science values led to the conclusion that unique and non-renewable ecological values are apparently present in the proposed project area, and futther study of their potential is necessary in order to allow the best possible philosophical and economic decisions about the location of the dam and the best use of the resource.

The National Park Service also recommended that a formal study be made to assess the ecological values. The study whould produce possible alternatives for the protection and utilization of the natural science values, and should also indicate priority areas for the salvage of ecological data should the site at mile 3.1 be selected. The State of Ohio and the Corps of Engineers concur in these conclusions and consider that it would be both appropriate and necessary to conduct a formal study assessing the ecological values to insure the best possible plan for preservation and enhancement within the Clear Creek Nature Area as presented herein. Such a study should be undertaken at the time of advance land acquisition which would be necessary to preserve the area from incompatible development.

Fish and Wildlife Service. The Fish and Wildlife Service evaluated the fish and wildlife conservation and enhancement aspects of Logan Reservoir at the two principal sites considered. Its report, included in Appendix G, indicated a preference for the upstream site because (1) "......greater length of tailwater along Clear Creek would provide for additional tailwater fishery" and (2) ".....the unique ecological community existing in Clear Creek Gorge and Rhododendron Valley would be preserved."

As recommended by the Fish and Wildlife Service, the following provisions have been incorporated into the plan of development:

Zoning of project land and water areas to regulate usage and additional studies of fish and wildlife resources, would be coordinated with the U. S. Fish and Wildlife Service and other appropriate agencies as the planning progresses. Reservoir clearing recommendations of the Fish and Wildlife Service would generally be followed unless interference with the

water supply pool's limits of clearing is encountered. If this occurs, coordination between all interested agencies would be maintained as the project progresses. The placement of adequate fish attractors may be then required. Multiple level intakes are provided in the preliminary design of the control structure with final elevation of intakes subject to further coordination at a later date. The requested minimum instantaneous flow of 15 cfs would be provided. Angler access to the recreational pool is being provided for as requested, but the sites have been adjusted to take advantage of sites to be developed for general recreation purposes. Tailwater fishery access would be provided as a part of the nature area at two locations. One location is just downstream of the dam as recommended by F&W. At the recommendation of the Ohio Department of Natural Resources, an additional access site would be provided about 2.5 miles downstream, near the entrance to the nature area. These two access sites would provide for more fisherman days use than originally planned by F&W.

Federal Water Pollution Control Administration. Studies to evaluate water supply and water quality control needs and to determine means to meet those needs were based on a detailed report prepared by the Public Health Service of the Department of Health, Education and Welfare in January 1965 and was included in the Interim Survey Report on Hocking River (House Document No. 287, 89th Congress 1st Session). Subsequently, in January 1966, after establishment of the Federal Water Pollution Control Administration, that agency reviewed the detailed report, and concluded that the needs discussed in the report were still valid with the time of first need in 1985. The alternative costs developed by the FWPCA were modified to reflect current interest rates and a revised project completion date. The needs were projected by the FWPCA for a 100-year period with the heaviest demand projected for late in the economic life of the reservoir project. Minor changes in the time of first need would have negligible effect on benefit evaluation. Any significant increases in water quality control demands would give rise to reconsideration of other potential reservoir projects within the Hocking River Basin. Early increases could be met by the Logan Reservoir without project modification. Should this occur, it would have the effect of increasing the benefits to be derived from the project.

U. S. Department of Agriculture. Through the various programs of several agencies in the Department, the planning and installation of land treatment measures will be accelerated and concentrated in the drainage area above the Logan Reservoir. This acceleration is part of the Recommended Plan for the Development of Water and Related Resources in Appalachia. It will improve and protect watershed values through reduction of runoff, erosion, and sedimentation. It will also strengthen the rural economy and improve environmental quality. For complete details, see Appendix A - Agriculture, Forestry and Conservation.

30. STATE AGENCIES

Coordination has been maintained throughout the course of these studies with the Ohio Department of Natural Resources and its various Divisions. The Department has been an active participant, particularly in developing plans for general recreation and in evolving a plan for preservation and enhancement of the Clear Creek Valley.

As a result of a series of meetings and discussions regarding the formulation of plans for Logan Reservoir, the Director of the Department of Natural Resources submitted a letter to the Huntington District Corps of Engineers on 8 July 1968. The Director, acting as the designated representative of the Governor in matters of mutual interest to the Corps of Engineers and the State of Ohio, recommended that the District Engineer proceed with development of Logan Reservoir with the additional feature that a comprehensive plan be developed to bring the entire Clear Creek Valley below the dam site under public ownership and management to insure its preservation as a natural area. Agreement has been reached by the State of Ohio, the U. S. Department of the Interior and the Corps of Engineers that detailed site studies be made between river miles 3.0 and 6.0 before a final selection of site and plan of development is made.

Subsequent discussions and a meeting of the Ohio Department of Natural Resources, Camp Fire Girls, Inc., and the Corps of Engineers resulted in a mutually agreeable proposal that, following authorization of the project as currently envisioned, negotiations would be entered into with the State of Ohio and Camp Fire Girls, Inc., to provide for a plan whereby that organization could continue to operate with the project bounds at the level of activity and quality of services, existing at the time of project authorization, in a manner that would be compatible with the operation and usage of other project lands.

31. LOCAL GROUPS

Valuable assistance was provided during the course of these studies by many local agencies and organizations; particularly by the Hocking Conservancy District. The conservancy district has acted as the local sponsoring agent to furnish required cooperation in the construction of the Athens Local Protection Project, and to furnish assurances of cooperation for the local projects being studied under continuing authorities provided the Chief of Engineers.

Conferences have been held with various local groups and letters have been received over a period of several years concerning the studies made for this report. Municipal, county and Ohio University officials and various local civic organizations have all expressed intense interest

in obtaining the maximum amount of flood protection that can be economically justified for the Athens area by any feasible method, including upstream reservoirs. Testimony at the public hearings held on 14 April 1964 and 13 November 1964, further indicated the desire for alleviation of flooding. Each of these hearings is discussed hereinafter.

A publication entitled "Commercial Tourism Potential of Hocking County, Ohio," demonstrates the awareness of local interests of the importance of recreational development. This report, prepared by Ohio University under an Area Redevelopment Administration grant, recommends development of lodging accommodations, increased facilities at existing parks, public and private development at potential Corps of Engineers projects, and a tourist council for promotional purposes.

32. PUBLIC HEARINGS

Public hearing at Athens, Ohio, 14 April 1964. The flood of March 1964 created a sense of urgency for protection at Athens that culminated in a determination that special consideration should be given to the local flood problem. In response to the demand for immediate attention to the local problem, a public hearing was held at Athens on 14 April 1964, to discuss plans considered for inclusion in an interim report on Athens flood protection. Approximately 85 persons attended the hearing, including state, county and municipal officials, members of the Hocking Conservancy District, representatives of civic organizations and interested individuals.

The Hocking Conservancy District reiterated its previously submitted resolution of willingness to serve as local sponsoring agency to furnish the required local cooperation. The conservancy district preferred that the selection and design of a plan for local protection at Athens be deferred pending completion of the Hocking River Survey Report in order to insure that the comprehensive plan for water resources developments for the basin would not be adversely affected by adoption of a premature local protection plan.

Public hearing at Logan, Ohio, 13 November 1964. Approximately 220 persons attended the public hearing at Logan which was held to discuss the tentative plan of improvement for the Hocking River Basin.

Local interests at Athens strongly indicated their preference for upstream flood control storage in the Logan Reservoir to be combined with a project at Athens including channel improvement only. Local residents within the reservoir area stated numerous objections to the Logan project. The most significant of these objections were the loss of unusual flora and fauna peculiar to the "gorge" area of the Logan Reservoir project and debasement of the natural beauty of this area. Some of these opponents favored moving the project to a point upstream which would avoid the inundation of the unusual "niches" of plant life

within the gorge area of the project. Conversely, many local interests have indicated through petitions that they favor the downstream site, as proposed herein.

One petition submitted in favor of the downstream site was signed by 107 landowners in the vicinity of the project. Statements from landowners opposing the project carried 16 signatures. All of those landowners in opposition to the project would be more directly affected by the project than would the majority of those landowners on record as favoring the project.

A list of local organizations submitting statements favoring the project follows:

Ohio Department of Natural Resources
Hocking Conservancy District
Ohio University, Board of Trustees
Ohio Valley Improvement Association
Athens County Board of County Commissioners
Athens County Soil and Water Conservation District
Village of Glouster
City of Logan
City of Athens
Village of Chauncey
Hocking County, Board of County Commissioners
Nelsonville Board of Trade
Logan Trade Club, Inc.

A list of local organizations submitting statements opposing the project follows:

Barnebey Foundation (Camp Indianola)

The Columbus and Franklin County Council, Camp Fire Girls, Inc., submitted a statement expressing concern relative to the possible adverse effects of the project on their operation. Their situation has been discussed previously in this report.

Public hearing at Logan, Ohio, 20 March 1969. The hearing was attended by about 500 persons. Represented were various Federal, State and local government agencies, civic leaders, industrial leaders, public officials, academicians, naturalists, conservationists, property owners, the press, and other interested citizens.

Interested parties were invited to express their views concerning the improvements being considered. Statements were presented by many individuals representing diverse views. Civic leaders, public officials, and many others generally advocated early construction. Naturalists and conservationists generally indicated that, if a project was necessary, they preferred the upstream site. A summary of statements and comments

submitted in connection with the hearing is contained in the following paragraphs.

State agencies

Dr. Robert W. Teater, Assistant Director of the State of Ohio, Department of Natural Resources, stated that the development of the water and related land resources in the Clear Creek Valley - Hocking River Basin, under the provisions of the Appalachian Regional Development Act 1965, is a major step in achieving effective management of these resources. The State of Ohio favors the site located 3.1 miles above the mouth and urges that the study be completed at the earliest possible time and is hopeful than an economically justified project will be formulated.

Mr. Paul Flanigan, Principal District Sanitary Engineer, Ohio Department of Health, stated that his Agency favored the construction of the Logan Dam and Reservoir Project.

City and local officials

Mr. R. B. Oakley, President of the Hocking Conservancy District, stated that the Logan Reservoir on Clear Creek is an important element in its official plan and considers the need for this project to be most urgent and intends to cooperate fully with the U. S. Army Corps of Engineers, the State of Ohio, and other agencies to secure its authorization and construction at the earliest possible date.

Mr. Paul E. Brown, Supervisor, Athens Soil and Water Conservation District, Athens, Ohio, stated that the Board of Supervisors unamimously supports the adoption of the Logan Dam and Reservoir Development Plan and stated that the project should be implemented as quickly as possible.

Mr. M. B. Haney, Mayor of Logan, Ohio, endorses the development as planned for Clear Creek Valley. Also, he stated that the project would not only serve for flood control and pure water supply, but would also make it possible to give some quality control of Hocking River during dry periods. In addition to completion of the Clear Creek Valley Reservoir, he recommended that consideration be given and action taken at the earliest possible time to provide additional local protection for the city of Logan. By the completion of both projects, not only will the natural ecology of the area be preserved and developed but the human ecology will also be preserved and not forgotten.

Mr. Dwight D. Robinson, Director of Public Service and Safety for the city of Athens, Ohio, on behalf of Mayor Raymond Shepard, endorses the proposed Logan Dam and Reservoir Project.

Mr. Howard C. Blum, President, Hocking County Commissioners, stated that the Commissioners endorse the Logan Dam and Reservoir Project on Clear Creek with their full legal prerogatives for the expedition of said project.

Mr. J. F. Parkinson, Director of Service and Safety, City of Logan, Ohio, stated that the City of Logan recommended that this important work proceed without further delay.

Mr. Frank W. Dounhauer, representing Mr. T. C. Porter, Superintendent of the Tri-County Joint Vocational High School and Technical Institute, Nelsonville, Ohio, stated that two-thirds of their land is subject to flooding; that Nelsonville depends heavily upon the Hocking River for its water supply; and supports the proposed reservoir, since it would be a definite asset to the overall economic development of the Hocking Valley.

Mr. George A. Mara, Hocking County Engineer, Logan, Ohio, endorses the proposed Logan Reservoir Project as part of the overall water resources development plan for the Area.

The Board of County Commissioners, Athens County, Ohio, submits its approval and urges the continuance of the processing of plans for the Clear Creek, Hocking River Basin, Logan Dam and Reservoir Development Plans.

Civic organizations

Mr. Barton S. Holl, President of the Logan Trade Club, an organization of over 200 retail, wholesale, industrial, and professional members, which was formed to promote growth and development in the Logan Area, urges that the proposed plan for Logan Dam and Reservoir be adopted and approved so that construction can begin and benefits may accrue.

Mr. Max Davidson, representing the Hocking County Community Improvement Corporation, (CIC) Logan, Ohio, formed by the Trade Club to make available to industry the land and buildings necessary to locate in the valley, which Corporation owns the present Lockheed and Goodyear plants, stated that the CIC, as well as the community of Logan, stands to lose these tenants and the resultant jobs and income if some positive action is not taken to reduce their flood losses. The Corporation urges proceeding with the 3.1 mile site with all possible haste.

The Athens Business Association, Athens Chamber of Commerce, Athens, Ohio, stated that the Board of Directors - representing a large cross section of the Athens community through its 304 professional, banking, manufacturing, service, utility, and retail memberships - endorses and enthusiastically supports the proposed plans for the

Logan Dam and Reservoir Project on Clear Creek.

The Community Improvement Corporation of Athens, Ohio, strongly favors the Logan Dam and Reservoir Project on Clear Creek as currently proposed.

Mr. Jack V. Oakley, Governor of the Nelsonville Board of Trade, Nelsonville, Ohio, stated that they approved the proposed Logan Dam and Reservoir Project on Clear Creek.

Mr. Richard H. Holl, Chairman of the Hocking County Planning Commission, endorses the plan for Logan Reservoir at the downstream site and urges that the earliest possible action be taken toward implementation of the plan.

Mr. Goff Dunfee, President, Athens County, Regional Planning Commission, endorses the plan for Logan Reservoir, and stated that construction at the earliest possible date is essential to future development in Athens County.

Mrs. David Onley, a representative of the Water Resources Committee of the Athens League of Women Voters, Athens, Ohio, urges that the proposed Logan Dam and Reservoir be built, to insure a supply of clean water for the many useful purposes envisioned and to control flooding in the Hocking River Basin. But, most of all, the Committee urges the use of this reserve of water to help control water pollution in the Hocking River.

Other organizations

Mr. Richard S. McCutchen, representative of the Columbus Audubon Society, Columbus, Ohio, stated that the Society stands uncategorically opposed to the primary 3.1 mile dam site and moves that the location of the dam be the proposed alternate, popularly known as the 5.7 mile site.

Mr. John E. Thompson, past President of the League of Ohio Sportsmen, stated that consideration should be given to the ecological aspects of the Clear Creek Gorge and that it be saved if at all possible.

Mr. D. A. Rigney, a representative of the Sierra Club, Ohio Chapter, stated that the ecological values of the gorge should be preserved and requests that a study be made of the feasibility of building a dam across Clear Creek at the 5.7 mile site.

Mr. B. T. Grover, Jr., President of the Athens National Bank, supports the Corps of Engineers and their efforts to develop this project.

Dr. David D. Blyth, a representative of the Wheaton Club, which is a group of some 200 biologists from central Ohio, stated that they were

opposed to the 3.1 dam, but that they were for people, flood control, recreation and for preserving the Clear Creek Gorge. They recommend a feasibility study of the other dam location.

Dr. Edward S. Thomas, owner of Neotoma and representing the Ohio Chapter of Nature Conservancy, stated that the Chapter was not opposed to flood control, outdoor recreation, water supply, or water quality control, but that they were unanimous in the belief that if a dam should be built in the Clear Creek Gorge, that it should be at the 5.7 mile site.

Mr. Dwight Rutherford, Chairman, Board of Trustees of the O'Bleness Memorial Sheltering Arms Hospital, Athens, Ohio, endorses the plan for the Logan Dam and Reservoir Project on Clear Creek.

Pearl Harley, Secretary-Treasurer of the Retail Merchants Association of Nelsonville, Ohio, stated that the Association approved the proposed Logan Dam and Reservoir Project.

The Athens Garden Club, with a membership of fifty, registered its unanimous dissent to the proposal to locate the Clear Creek Dam at a point 3.1 miles above the mouth and strongly urge and endorse the alternate site 5.7 miles above the mouth.

The Board of Directors of the Columbus and Franklin County Camp Fire Girls, Inc., stated the Board was not opposed to the building of a flood protection dam in Clear Creek Valley, but would oppose condemnation and taking the property of Camp Wyandot and could not accept the provisions of a lease, in lieu of ownership.

Mr. G. Kenner Bush, Publisher of the Athens Messenger, Athens, Ohio, stated that "the delay of three decades in construction of this facility has been a tragic delay for our valley. This time, let's build the Logan Dam and Reservoir on Clear Creek."

Mr. Thomas E. Dustin, National Vice President, The Izaak Walton League of America, stated that it would seem most appropriate to do everything possible to assure the highest quality environmental preservation program, saving as much as possible of the natural land forms and ecological communities, while there is still an opportunity to do so.

Industry

Mr. Carl Goldsberry, Area Manager for the Ohio Power Company, which furnishes electrical power to the city of Logan and the surrounding area, and therefore, has an interest in the continuing development of the Hocking Valley, urges that the project be constructed at the recommended site at the earliest possible date.

Mr. Barton A. Holl, President of the Logan Clay Products Company, Logan, Ohio, stated that the Company was in favor of the 3.1 mile location and approves the overall development plan. They have 250 employees, and the only work stoppage they have had in thirty years is when the Hocking River is at flood stage.

Mr. J. E. Holaday, Plant Manager, Goodyear Tire & Rubber Company, Logan, Ohio, stated that without preventative measures being taken the company would continue to incur periodic property damage and loss of production, which places the operation under a severe competitive handicap.

Mr. J. D. VanVoorhis, Manager of the Lockheed-Georgia Company, Logan, Ohio, stated that the location of the proposed dam was immaterial, but if any change caused further delay in the start of the flood control project, then the Company was opposed to the change.

Academicians

Mr. Ronald L. Stuckey, Assistant Professor of Botany and Curator of the Herbarium at Ohio State University, urges preservation of the flora and as much of the gorge as possible, and for the Corps of Engineers to reconsider and study as thoroughly as possible to find the means to build the dam at the 5.7 mile site.

Mr. Robert Platt, Assistant Director of Botany, Ohio State University, urges preservation and that the gorge area be preserved in any manner possible.

Mr. Gareth E. Gilbert, Associate Professor of Ecology at Ohio State University, pleads that the State of Ohio not only reverse its approval to build the dam at the 3.1 mile site, but also not to approve it at the 5.7 mile site, or at any location in the Hocking Hills.

Mr. Paul O'Brian, Secretary of the Board of Trustees of Ohio University, Athens, Ohio, stated that the President and the Board of Trustees support the U. S. Corps of Engineers, the Hocking Conservancy District, and the Ohio Department of Natural Resources, and the efforts to develop projects in the Hocking Valley and that they endorse the Logan Dam and Reservoir Project and urge everyone to pursue to the fullest the construction of this project so that all families, their children and the supporting industries can enjoy the benefits of the project as soon as possible.

Mr. Richard H. Bohning, Dean of the College of Biological Sciences, Ohio State University, stated that the college is opposed to the inundation of Clear Creek gorge and would like to see an alternate site.

Dr. Adolph Waller, Professor Emeritus, Botany, Ohio State University, favors preservation and to getting the result of all the complications involved.

Oral statements by individuals

Of the 15 statements presented, seven opposed a dam at stream mile 3.1 and favored the 5.7 mile site if a dam is to be built, six opposed a dam at any site, and two favored development at the 3.1 mile site.

Petitions

Several petitions were submitted in connection with the hearing. No attempt has been made to check the signatures for duplication. A summary of the petitions is contained in the following paragraphs.

A petition with 327 names, submitted by the Drinkle and Martin Law firm, which reads as follows:

"We, the undersigned residents and owners of land in the area which would be consumed by the 'Logan Dam Development Plan' respectfully request a reconsideration of the plan and elimination of the dam on Clear Creek in the interest of maintaining the natural beauty, wildlife, and land."

A petition with 124 names, submitted by Mr. Bill R. Davis, which reads as follows:

"We the undersigned residents and owners of land in the area which would be consumed by the 'Logan Dam Development Plan' respectfully request a reconsideration of the plan so that only the land necessary to the construction of the reservoir will be taken and to place more emphasis on maintaining the natural beauty, wildlife, land and homes now existing to include present ownership."

A petition with 959 names, submitted by Mr. W. E. Benua, which reads as follows:

"Inasmuch as the proposed dam in the Clear Creek Valley known as Site 3.1 will result in the flooding and destruction of some of the finest portions of this scenic valley, along with its wealth of rare plants and animals, we request that the U. S. Army Engineers be instructed to make a survey of the feasibility of the construction of a dam at Site 5.7, where destruction of scenic features, plants and animal life will be minimal."

A petition with 28 names submitted by Mrs. Marian Hall DeBolt, which reads as follows:

"We the undersigned are expressing herewith our opposition to any construction of a dam or recreation area in the Clear Creek Valley by the Army Egnineers or any other agency."

A petition with 25 names, submitted by Mr. Gary L. Myers, which reads as follows:

"We the undersigned do hereby petition for the lower dam site considered for Logan Reservoir (3.1 miles from the mouth of Clear Creek)."

Documents

A 77 page document in opposition to the Corps of Engineers proposed Logan Dam and Reservoir Project was received from the law firm of Leva, Hawes, Symington, Martin and Oppenheimer of Washington, D.C., which represents Mr. and Mrs. W. E. Benua of Rockbridge, Ohio. Its conclusion is two-fold: first that the Corps has failed to justify construction of any reservoir on Clear Creek; and second, that even if such a reservoir were to be built, the Corps should select an alternative location.

Correspondence

A total of 65 letters were received from individuals in direct response to the public hearing, prior to the 18 April 1969 closing date. Thirty-six letters indicated opposition to a dam at the 3.1 mile site and requested the Corps to reconsider locating the dam at the alternative 5.7 mile site, to preserve the gorge for its scenic and ecological values. Only one of these 36 correspondents indicated he was a property owner in the area affected. Twenty-five individuals, ten of which indicated they were property owners in the area affected, were opposed to construction of a dam in the Clear Creek Valley. Four letters favored the development plan now being considered.

Several letters addressed to others concerning the study have been referred to the Huntington District for response, and copies of letters answered by others have been provided for information. A substantial amount of correspondence continues to be received subsequent to the closing date for inclusion in the transcript of the hearing. Appropriate replies are being furnished to all letters although those received late are not tabulated for the record.

33. PROCEDURES FOR PLAN IMPLEMENTATION

Conversion to reality of the plan of development for the Logan Dam and Reservoir Project, as proposed herein, will require close coordination between the Corps of Engineers and the Ohio Department of Natural Resources, and careful attention to sequencing of the various steps of the plan.

After authorization, detailed site investigation and design should be made concurrently with the detailed study recommended by the National Park Service for the purpose of accurately defining the project lands required. These studies will be the basis for an advanced land acquisition program for the proposed project, including the Nature Area. Advance acquisition of such title to such lands as may be required is considered necessary to preserve the site against incompatible development.

At the time of advance acquisition and subsequent to completion of studies recommended by the National Park Service, a master plan for coordinated development of recreation facilities and of the nature area would be worked out with the Ohio Department of Natural Resources which would assume responsibility for operating and maintaining these developments. The master plan would include details of measures to prevent unnecessary despoilation or disturbance of the natural environment during construction in addition to plans for reclaiming and beautifying construction areas. Advanced engineering and design would then continue through its normal course.

All land acquisition and construction would be the responsibility of the Corps of Engineers. Recreation facilities and the nature area would be turned over to the Ohio Department of Natural Resources for operation and maintenance in accordance with the master plan of development. The Corps would be responsible for operation and maintenance of the dam and reservoir.

34. DISCUSSION

The existing authorization for the Logan Dam and Reservoir is limited essentially to providing for flood control and uses incidental thereto. Over the period of 31 years since authorization, the water resource and economic conditions within the Hocking River Basin have changed considerably and have become more interrelated and complex. The present economic disadvantages and the prospects for future economic progress relate to the full range of water and related resource deficiencies. Only multiple-purpose development would respond to the spectrum of current composite problems. Yet total response will be difficult to achieve. Practical and financially sound opportunities for development of water resources are extremely limited.

Extensive efforts have been made to provide economical solutions to critical individual or localized problems. The combined programs of the U. S. Department of Agriculture and the Corps of Engineers have resulted in substantial progress toward alleviating problems and meeting needs in tributary sub-basins. But the bulk of economic, social, and cultural enterprise within the basin is concentrated along the main stem of the Hocking River.

During the course of past and current investigations, it has become apparent that resolution of flood problems along the main stem for National Efficiency Objectives cannot be feasibly achieved by local protective measures alone. Complementary measures, both structural and non-structural, will be required to attain a viable solution. All potential local projects as well as the Athens Local Protection Project, now under construction, have been planned in context with a total comprehensive plan. A reservoir on Clear Creek is an essential, urgent part of this plan since reservoirs on other tributaries would not be as efficient, especially for multiple-purpose development. Whereas some of the possible reservoirs on other tributaries could be developed to provide desirable flood control, disregarding benefit-cost efficiency, few, if any, of these alternative projects could provide for multiple-purpose development, including water supply, water quality control, general recreation, and fish and wildlife enhancement at this time because of polluted stream conditions.

Thus the Logan Reservoir evolves as the best opportunity at this time for multiple-purpose development within the Hocking Basin. The investigations reported herein primarily were designed to determine whether an economically justifiable project could be developed on Clear Creek, and whether such a project would respond to multiple-purpose objectives. The investigations disclose that such a project can be developed, and that, on the basis of economic analyses,

and project efficiency (excluding any monetary value for not inundating a portion of the gorge), the dam site 3.1 miles above the mouth of Clear Creek would be the most favorable of the alternatives.

However, certain critical aspects involving environmental quality make conclusions as to specific site selection extremely difficult. Testimony at the public hearing held 20 March 1969, represented divergent views regarding the ecologic and aesthetic issues involved. This testimony and subsequent correspondence, combined with the views of other agencies, both Federal and State, clearly have established the need for detailed design and cost analyses of all possible alternative sites and a comprehensive investigation of ecological values upon which to base a valid, final decision.

With the inclusion of the Nature Area, the plan presented herein mitigates the damages caused by inundation of the valley above the 3.1 mile dam site and maximizes the utilization of the valley downstream from the dam site. By placing the valley in public ownership, the area can be preserved in its natural state and with controlled public usage, can be studied and enjoyed to the greatest advantage by the general public. To forego public ownership of the Nature Area, either by not including such a plan with a dam site remote from the gorge area (further upstream) or by not developing a reservoir project at all, would not insure preservation nor enable persons desiring to visit the area to do so. In fact, the current situation indicates the opposite; lands now in private ownership to a great extent are posted against trespassing. Demand for residential and commercial development in the area will increase, particularly if a reservoir project with associated recreation is developed without provision for a nature area. In that case, only a limited number of people would realize benefits, and those most interested in preserving the aesthetic and ecologic attributes of the area probably would be excluded.

The eventual decision regarding site selection would not appear to alter the principal conclusion that a multiple-purpose reservoir on Clear Creek, incorporating essential features generally as provided for herein, would be economically justifiable on the basis of national efficiency; would promote the general welfare and economic well-being of the region including substantial tangible and intangible gains to Appalachia; would be responsive to the composite of water and related resources needs of the basin as well as to the intense regional demands for water-based recreation; and would constitute an integral part of an optimum basin plan.

Regardless of the site selected, the project would serve as a major element in the National Recreation Area being considered by the Bureau of Outdoor Recreation. However, because of the intense demands for outdoor recreation opportunities, especially in view of

the prospects and high state priority for establishment of a National Recreation Area, with the reservoir serving as an element and because of the project's excellent and unique potential for meeting a portion of these demands, the optimum plan of development would deviate from the intent of Section 9 of PL 89-72 in that the sum of the costs allocated to recreation and fish and wildlife exceed the sum of the costs allocated to the other purposes.

35. CONCLUSIONS

It is concluded that:

a. Existing project authorization is not responsive to current needs;

b. Exact dam site selection should be made during advanced engineering and design when in-depth ecological determinations can be made by all affected Federal, and non-Federal interests;

c. Studies reported herein are in complete response to Resolution of the Committee on Public Works of the House of Representatives adopted 16 August 1950; and

d. Modification of existing authorization for Logan Dam and Reservoir, essentially as outlined in this report, is required.

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 16

MIDLAND LOCAL PROTECTION PROJECT

LICKING RIVER BASIN

KENTUCKY

Office Of Appalachian Studies

Corps Of Engineers

October, 1969

DEVELOPMENT
OF
WATER RESOURCES
IN
APPALACHIA

PART III

PROJECT ANALYSES

CHAPTER 16 - MIDLAND, KENTUCKY LOCAL PROTECTION PROJECT

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PART III
PROJECT ANALYSES

CHAPTER 16 - MIDLAND KENTUCKY LOCAL PROTECTION PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Situated adjacent to Interstate 64 and the Licking River, near Morehead, Kentucky, is an area which has excited the interest of civic planning leaders who recognize the tremendous opportunity for creation of a full service urban center, in an economically depressed area in Appalachian Kentucky. This location, Midland, Kentucky, was identified by the Commonwealth of Kentucky, through its Kentucky Area Development Office, as a designed potential urban service center (or potential "new town"). It is located in Bath and Rowan Counties, approximately midway between Lexington and the Ashland-Huntington metropolitan areas. Lexington is 55 miles west of Midland and Ashland-Huntington is 65 miles northeast. The Cincinnati metropolitan area is northwest of Midland, 140 miles distant via Interstate Highways 64 and 75.

Midland is conceived as a regional employment and service center for the nine surrounding counties. The Midland development plan consists of two interdependent components - the industrial district and the community center complex. The industrial district would be located along the western edge of the development, keyed to the excellent rail and highway facilities. The principal elements of the community center complex would be the central business district, the civic center, educational and health institutions, residential areas, and prime recreation facilities.

Midland would occupy a portion of the flood plain of the Licking River, between Cave Run Dam and the head of Falmouth Reservoir, and adjacent areas which are topographically suited for development. The core of the development would be the flat lands of the flood plain which will be exceptionally well protected by Cave Run Reservoir against flooding by the Licking River. Previous hydrologic studies indicated that the Cave Run Reservoir would practically eliminate floods in the 30 mile segment of stream immediately below the dam site. However, revised hydrologic data on discharges from Triplett Creek revealed that flat flood plain land below Cave Run Dam would remain vulnerable to flooding by Triplett and Salt Lick Creeks.

In order to realize the full potential of the urban service center development, it would be necessary to provide a local protection project to safeguard the core area from residual flooding. This element of the

development will hereinafter be referred to as the Midland Local Protection Project or "the project". The analyses and design considerations which established the project's design and dimensions are presented in subsequent Sections of this Chapter.

The Midland Local Protection Project would protect six areas along the Licking River within a 12 mile reach downstream from Cave Run Dam, now under construction at mile 173.6 on the Licking River. (See exhibit 16-1).

The principal physical features of the project consist of six levee sections totaling 59,650 feet, a 250-foot concrete wall section, and 1,500 feet of Licking River channel realignment. The levees would have a top width of 12 feet and average heights of the levee sections would vary from about 12 to 18 feet. The concrete wall would be about 14 feet high. The realigned river channel would have a bottom width of 50 feet and a maximum cut of about 19 feet. Raising about 4,200 feet of U. S. Highway 60 will also be necessary.

2. PROJECT IMPACT

Cave Run Reservoir affords virtually complete elimination of flooding from Licking River in the Midland area. This creates an opportunity to construct a local protection project, phased to be consonant with the urban service center development, which would furnish protection against tributary flooding for developable lands which will comprise the core of the urban development. Since there is a dearth of such land in this economically depressed region, the project would catalyze the developmental potential to assure the success of the planned industrial district and residential and business community.

The nine-county area centered around the development project, shown in figure 16-1, would receive the principal economic impact. However, economic effects would extend to other areas both within and without the Appalachian Region.

The developmental plan, with the local protection project, is expected to increase the study area's population by 36,900, provide 35,600 jobs (including 24,000 primary jobs), and reduce the ratio of population-per-employee from 3.25 to 2.30.

The elements of the protection project have been designed for staged construction to provide the needed protection in three phases, 1980, 2000, and 2020, keyed to the plan of development. The projected total developmental land requirements are 1,630, 4,100, and 7,100 acres, respectively, at the aforementioned time phases. The initial impetus to the economic development of the study area would be provided by the employment opportunities afforded by project construction and it would be sustained and amplified through the job opportunities furnished by the industrial development as it reaches ultimate proportions.

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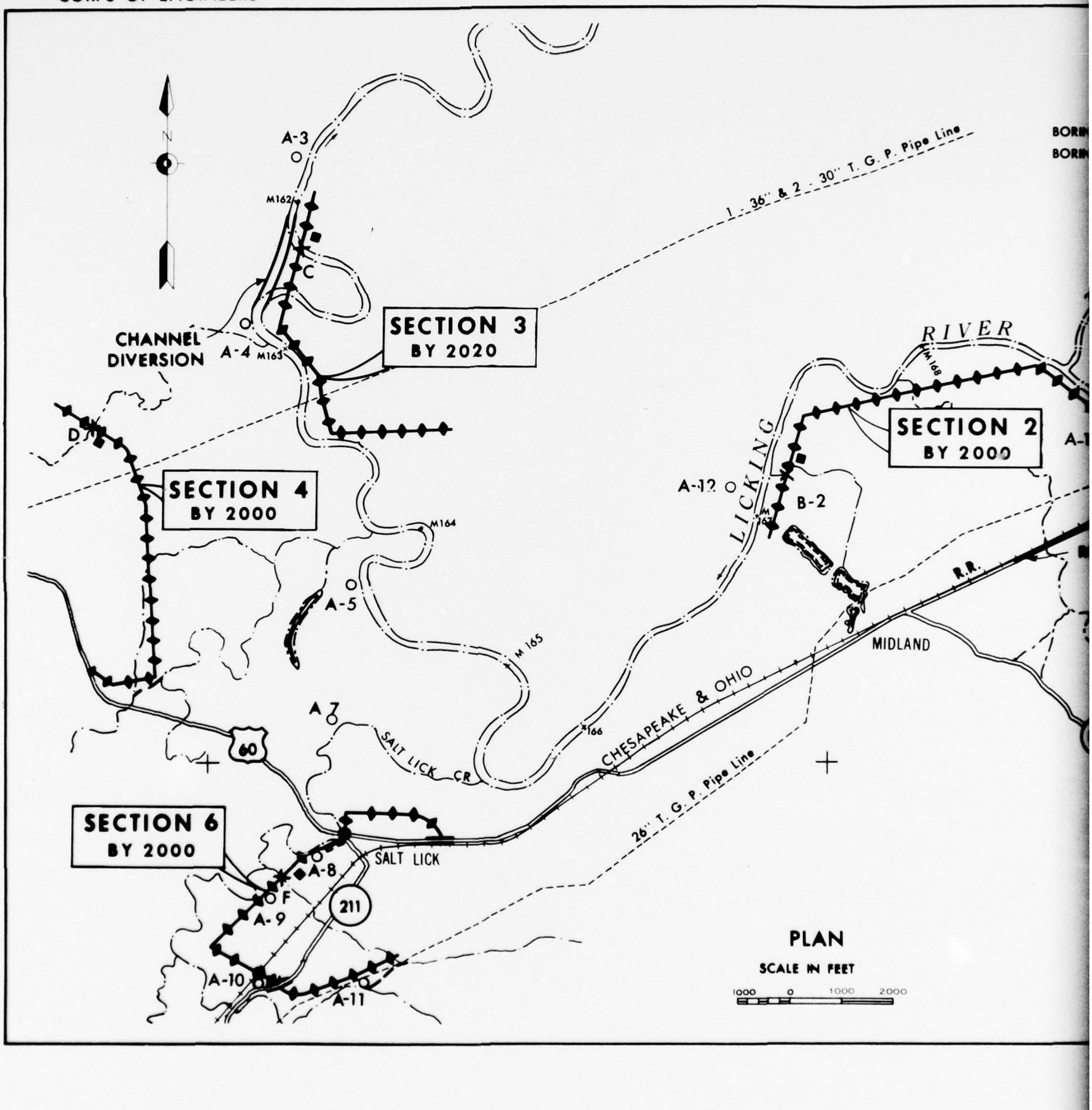

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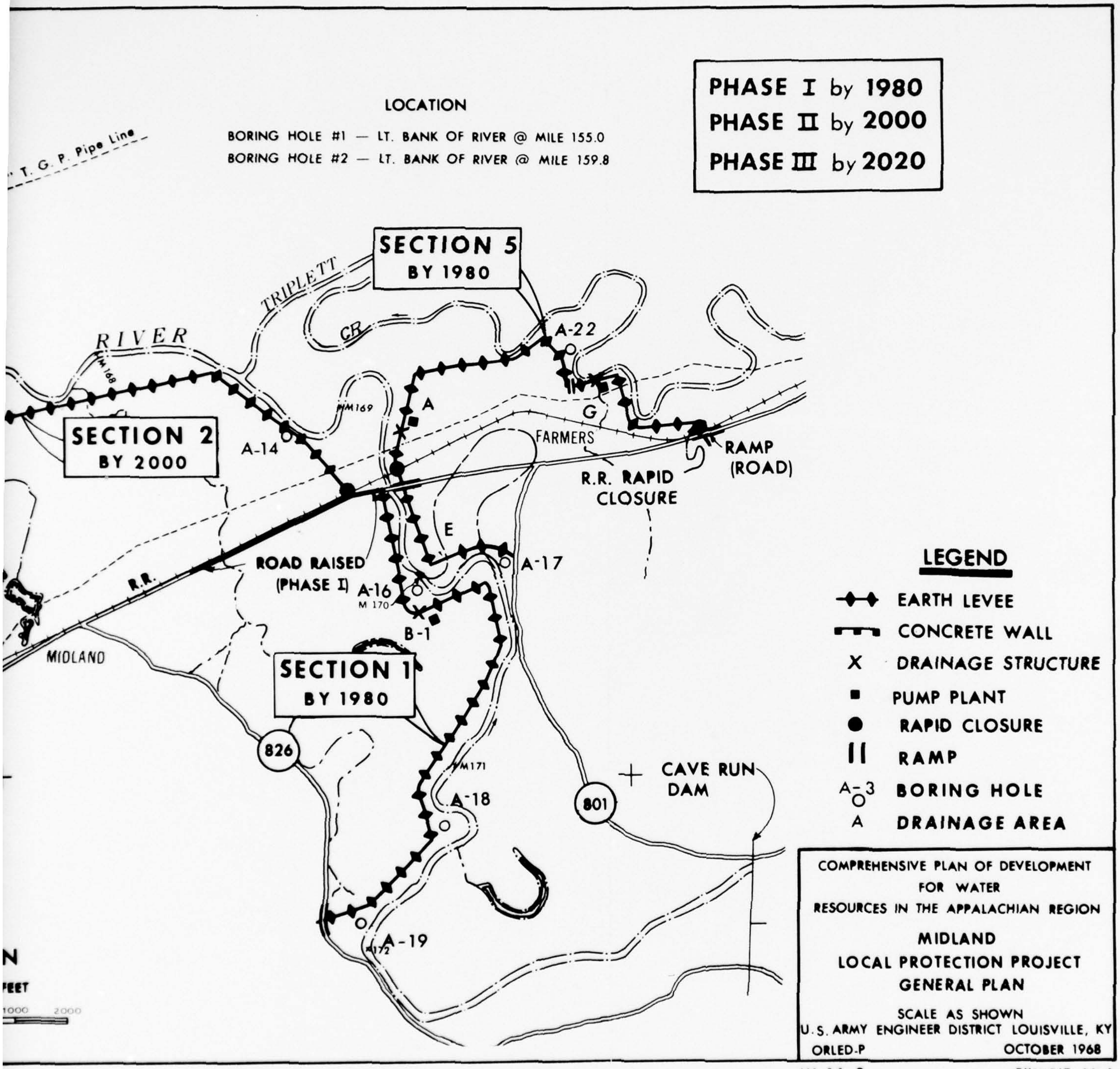

EXHIBIT 16-1

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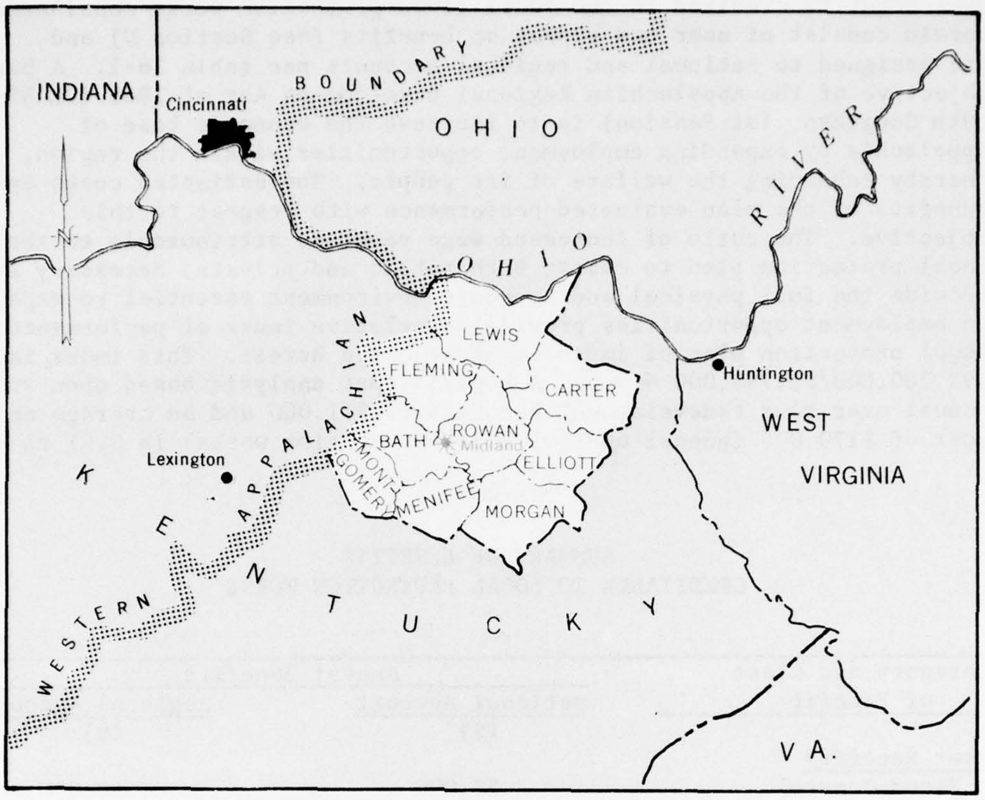

Figure 16-1. Area of Economic Influence (Study Area).

To determine the project's impact on the urban development plan, the potential economic benefits of the development with and without the project were estimated. The project is credited only with the net difference in benefits. This analysis clearly shows the economic justification of the project and its impact on the development and its area of influence. Tables 16-1 and 16-34 summarize the net benefits attributable to the Midland Local Protection Project.

3. ECONOMICS

The total first costs of local protection works recommended at Midland is $8,230,000. Net investments in the developmental plan, i.e. those investments occasioned by the local protection projects, would total $388,000,000 by 2020. The sum of these two figures, $396,230,000 represents the estimated initial net investment in all development programmed at Midland. Average annual equivalent values of these three amounts based upon a 3-1/4 percent interest rate and a 100-year period of analysis (1970-2070) are $170,000, $9,620,000 and $9,790,000, respectively.

Benefits credited to the local flood protection works considered herein consist of user and expansion benefits (see Section V) and are assigned to national and regional accounts per table 16-1. A basic objective of the Appalachian Regional Development Act of 1965 (PL 89-4, 89th Congress, 1st Session) is to increase the economic base of Appalachia by expanding employment opportunities within the region, thereby enhancing the welfare of its people. The estimated costs and benefits of the plan evaluated performance with respect to this objective. The ratio of increased wage payments attributable to the local protection plan to costs, both public and private, necessary to provide the full physical and economic environment essential to expansion in employment opportunities provides a relative index of performance of the local protection plan of improvement selected herein. This index is: \$92,380,000/\$9,790,000 = 9.4. A benefit cost analysis based upon average annual user plus redevelopment benefits of \$71,000 and an average annual cost of \$170,000 (annual cost of local protection works) is 0.41 to 1.0.

TABLE 16-1

SUMMARY OF BENEFITS
CREDITABLE TO LOCAL PROTECTION WORKS

Category and Class of Benefit	Annual Benefits	
	National Account (\$)	Regional Account (\$)
User Benefits		
Flood Control	52,000	52,000
Enhancement	12,000	12,000
Subtotal	64,000	64,000
Expansion Benefits		
Redevelopment (wages)	7,000	18,000
Development - Wages	16,271,000	92,362,000
Subtotal	16,278,000	92,380,000
TOTAL	16,342,000	92,444,000

4. LOCAL COOPERATION REQUIRED

Prior to initiation of construction of any section of the flood control element of the plan, non-Federal interests should furnish standard (a,b,c) assurances and agree to assume the portion of the costs of raising a section of U. S. Highway 60 assigned to local interests in accordance with present Corps of Engineers policy.

Also, prior to initiation of construction, local interests shall furnish assurances satisfactory to the Secretary of Army that there is reason to believe that programs and measures necessary to accomplish the economic development objectives of the developmental plan will be instituted in such a manner as to secure effective realization of these objectives.

In addition to the cooperation requirements outlined above, the Midland Industrial Foundation or an appropriate local or Commonwealth agency would be required to furnish assurances that effective regulatory controls would be established and enforced to prohibit obstructions and constrictions of the natural and modified Licking River channel which would affect the line of protection of the Midland Local Protection Project.

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SECTION II - PLAN AND PROJECT FORMULATION

5. PLAN FORMULATION - INTRODUCTION

As a result of the Cave Run Reservoir, now under construction at mile 173.6 on the Licking River, and of Interstate Highway 64, which passes through the area, about 30 square miles of Appalachian land will soon be enhanced for development. Realizing this fact, an advisory group of citizens from five eastern Kentucky Counties (Bath, Rowan, Menifee, Montgomery, and Morgan) incorporated the Midland Industrial Foundation in early 1967. In March 1967 this foundation asked the Kentucky Area Development Office for assistance in determining the area's economic potential and in designing a developmental plan for Midland. The Kentucky Area Development Office contracted with Spindletop Research Center of Lexington, Kentucky, and the University of Kentucky's Institute for Environmental Studies to accomplish these tasks. The Institute for Environmental Studies has prepared a developmental plan that will intensively use approximately 7,100 acres of flat land lying in the 30-square mile tract immediately downstream from Cave Run Dam. The Appalachian Regional Commission partially funded the developmental research.

Since Cave Run Reservoir provides no control of runoff from Triplett and Salt Lick Creeks, development of certain areas surrounding the existing towns of Midland and Salt Lick would be precluded by the absence of local flood protective works. This Chapter examines the practicability of a planned urban center at Midland and the economic feasibility of local flood protection works necessary to allow implementation of Midland's full developmental potential.

Objectives - A basic objective of the Appalachian Regional Development Act of 1965 (PL 89-4, 89th Congress, 1st Session) is to expand economic opportunities within the Appalachian region, thereby enhancing the welfare of its people. The Appalachian program's "growth center" concept was conceived as one means of accomplishing this objective. A rural urban center can provide economic opportunity to the rural poor thereby channeling them into small urban centers and away from ever-growing metropolitan ghettos.

The developmental plan presented herein is calculated to make the area more attractive to industries seeking plant locations. Industrialization of the area would increase employment and per capita incomes and allow the area to share in the Nation's affluence. This report has three objectives. First, the area's economic potential must be ascertained. Secondly, the impact that realization of the developmental plan would have on the region must be measured, and thirdly; the need for and value of considered local protection works must be defined. Justification of these works rests almost entirely upon future development. Therefore, the extent of development occasioned by them and benefits resulting from this development must be quantified as a measure of justification.

Area of Economic Influence - In order to evaluate performance and economic impact an urban development center at Midland would have on the region, it is necessary to establish geographic boundaries defining the area of primary influence. Criterion for selecting this area was predicated upon a study of unemployment and ease of travel for commuting workers and upon availability of data for small areas. The Midland area lies along both banks of the Licking River in Bath and Rowan Counties, Kentucky. These counties are within OBE economic sub-regions 1/ 13 and 12, respectively. In addition, both counties border economic sub-region 9. Necessary data are available on these OBE sub-regions; however, these three sub-regions constitute an area larger than the area from which a labor supply can be drawn. A maximum commuting distance of 25 miles was considered appropriate to establish an area from which a labor supply could be effectively drawn. Nine eastern Kentucky Counties lie within a 25 mile radius of Midland and since the county is the smallest political subdivision for which necessary economic and demographic data are available these nine counties have been selected as the primary area of economic and demographic influence (the study area). This study area is shown on figure 16-1.

Study Area Needs - The Appalachian Region's economic performance has noticeably lagged behind the Nation's, especially since 1940. The nine-county study area lies entirely within the Appalachian Region, and its economy has also lagged the Nation's and the rest of Appalachia. This poor performance is revealed by comparing percent changes in historical population and employment records of the study area against similar records for the Nation and Appalachia. Population and employment records for these three areas have been projected to year 2020. These projections reflect historical trends and are based upon similar projections by OBE. They indicate that population and employment of the area will increase considerably in the future, but these increases will still be lower than corresponding increases for the Nation and the study area will remain in a depressed condition. Relative changes in population and employment are shown on figures 16-2 and 16-3, respectively, for the period 1950 to 2020.

1/ The Office of Business Economics, U.S. Department of Commerce, has divided the Appalachian Region into economic sub-regions.

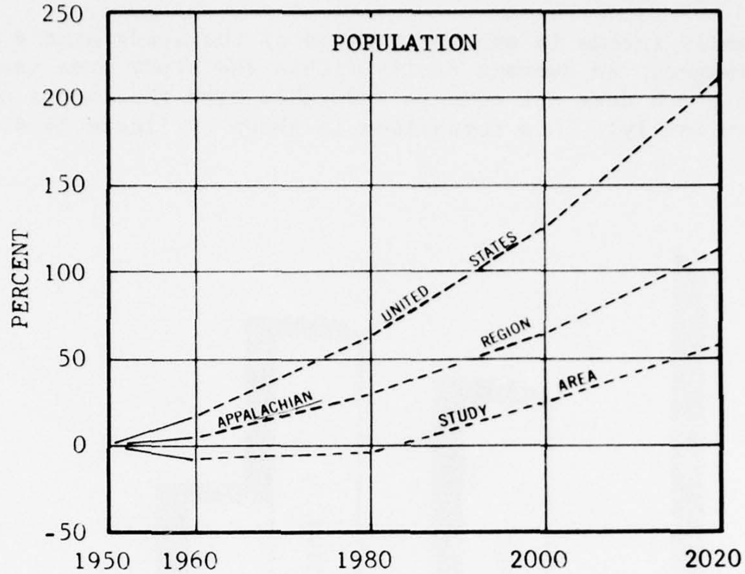


Figure 16-2. Relative Change in Population. (1950-2020)

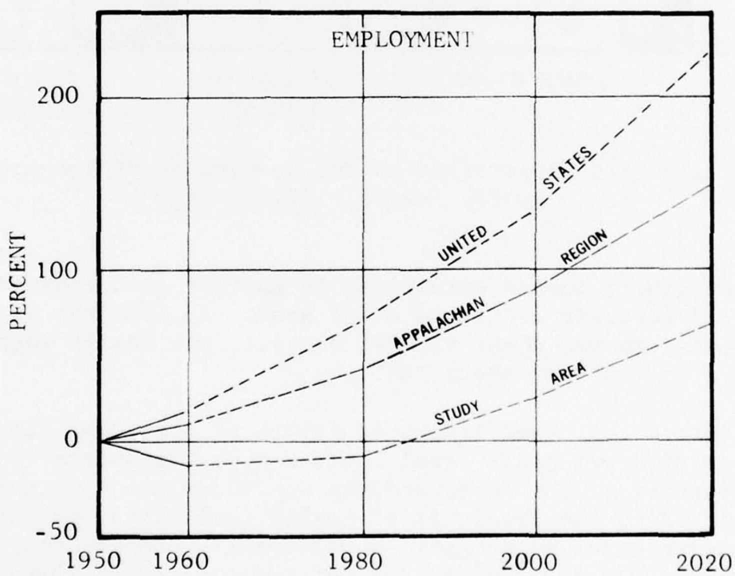


Figure 16-3. Relative Change in Employment. (1950-2020)

Family income is another measure of the study area's poor economic performance. An average family within the study area has an annual income which does not compare favorably with the income of the Nation's average family. This comparison is shown by figure 16-4.

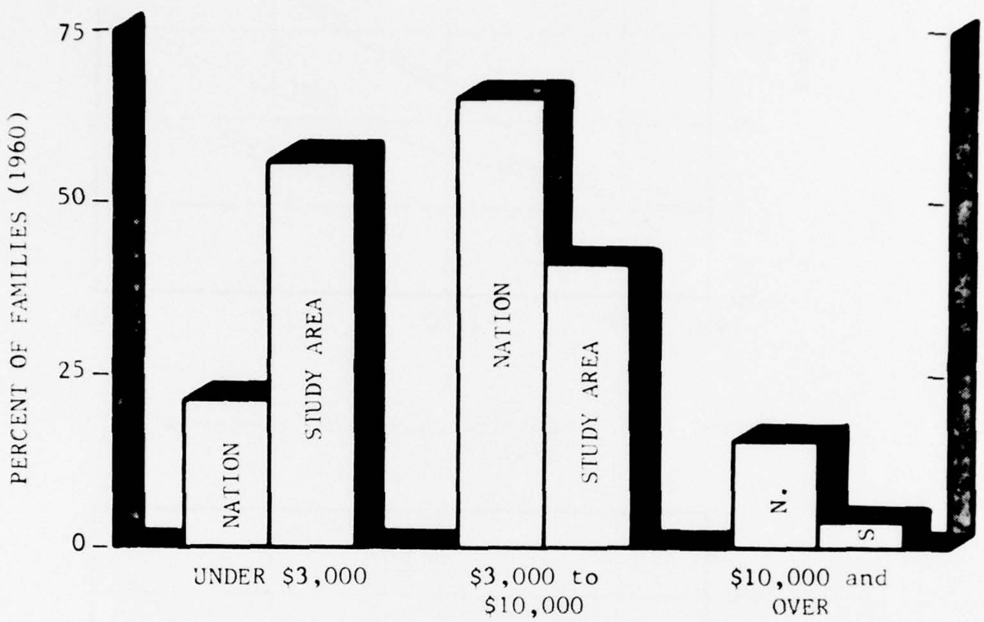


Figure 16-4. Distribution and Comparison of Average Annual Family Income. (1960)

Per capita income comparison is another good indicator of the relative economic condition of an area. In 1960 the Nation's per capita income was about $2,000; whereas, per capita income of the study area was only about $865.

Factors that have inhibited growth of the area include limited amounts of developable level land, a poor transportation system, and a dependency of the local economy on declining agricultural activities. Also, the low level of public facilities and services has been detrimental to economic development. Comparisons of population, employment, family income, and per capita income, show that the study area's economic performance does not compare favorably with the Nation's. Therefore, the need for alleviating growth impediments and for inducing industrial expansion within the study area is evident.

Study Area Assets - Economic base studies conducted for the Midland area revealed several prime locational advantages which provide evidence that the area has a significant development potential as a regional employment and service center. It offers a combination of industrial, residential, and commercial location advantages on a scale unavailable elsewhere in Appalachian Kentucky. These advantages are summarized as follows:

a. Labor Force Available - The labor supply available to the Midland area is attractive to industry. This labor supply is broken down into categories in table 16-2. Also, it can reasonably be expected, because of the lack of jobs in the past, that there is a substantial group of unemployed persons who have not been accounted for in the table below as they are not included on unemployment insurance rolls. The labor force would also be augmented by people who would return to the area if jobs were made available.

TABLE 16-2

POTENTIAL AVAILABLE LABOR IN THE MIDLAND
LABOR SUPPLY AREA - JUNE 1966

Total Labor Supply			Underemployed*		Unemployed	
Total	Male	Female	Male	Female	Male	Female
10,220	5,633	4,587	3,843	4,364	1,790	223

* Includes people who are underemployed and who would enter the labor force if jobs were available.

b. Land Availability - There is a substantial amount of flat land suitable for industrial and commercial use with sufficient auxiliary land to allow joint expansion of industrial, residential, public, and quasi-public facilities. There are about 12,100 acres of flat river-bottom land, 4,500 acres of flat ridgetop land, and 4,300 acres of moderately rolling but developable ridgetop land in the Midland area.

c. Transportation - The area is ideally located adjacent to Interstate Highway 64 (under construction) which is, in turn, linked directly to a good multistate highway network. Also, a proposed north-south highway between Maysville on the Ohio River and Campton on the Mountain Parkway, will pass through the Midland area. Existence of the main line of the Lexington Division of the Chesapeake and Ohio Railroad offers potential shipment by rail to and from major urban centers via Lexington and Ashland. The study area's major transportation facilities are shown on figure 16-5.

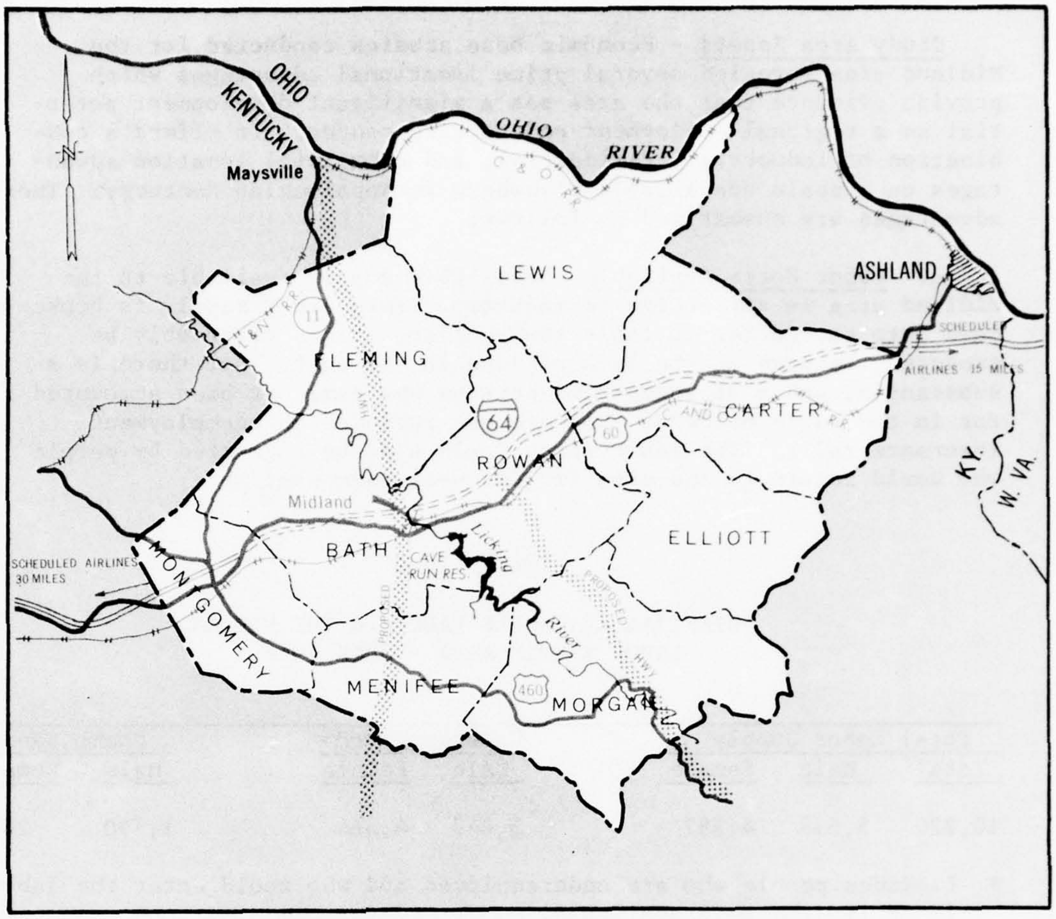


Figure 16-5. Existing and Proposed Transportation System.

d. Recreation - The recreation facilities of Cave Run Reservoir project and the contiguous area of Daniel Boone National Forest, administered by the U.S. Forest Service, will provide recreational opportunities which will attract visitors from a widespread area. Falmouth Reservoir (authorized) and its recreation facilities, located immediately downstream, will also entice many recreationists to visit the area near Midland. These extensive outdoor recreation facilities are expected to induce private investment in supportive recreation development, as well as enhance the attractiveness of the public recreation areas and facilities included in the Midland developmental plan.

e. Local Supporting Agency - The Gateway Area Development Council, which consists of citizens from Bath, Towan, Menifee, Montgomery and Morgan Counties, is a forward-looking group that is active in trying to alleviate poor economic conditions within their counties and by promoting development at Midland. It is expected that this council and the Commonwealth of Kentucky's Area Development Office would furnish strong local support of development in the Midland area. Vigorous support on a local level is necessary for a regional development center to become viable.

Developmental Plan - Having established a need for development within the study area and having catalogued the area's positive forces, the next logical step was to formulate a developmental plan for the area. In formulating a developmental plan at Midland it was first necessary to measure the developmental potential of a regional urban center in that area. Studies conducted by Spindletop Research Center provided the data furnished in table 16-3. These data define the ultimate potential of the study area which can be realized by urbanization at Midland.

TABLE 16-3

ULTIMATE POTENTIAL OF THE STUDY AREA WITH A REGIONAL URBAN CENTER AT MIDLAND

	Time Frame		
	1980	2000	2020
Potential Employment	8,400	21,600	35,600
Potential Wages (millions)	$ 44	$ 155	$ 326
Potential Population	5,200	15,600	36,900

With the area's potential for development established, this potential was selected as the developmental goal and a plan for development of Midland was formulated to meet 100 percent of the potential. This developmental plan, like the potential, is structured in three phases, 1980, 2000 and 2020. Sketch plans showing development to be in place by these points in time are shown on exhibits 16-2, -3, and -4. These sketch plans show the proposed location of industrial, commercial, service, and residential areas and also include a transportation plan for the area. Cost and investment estimates are based upon these sketch plans. An estimate of investment was derived for each component and phased to year 2020. A summary of total investment and land needs is shown in table 16-4.

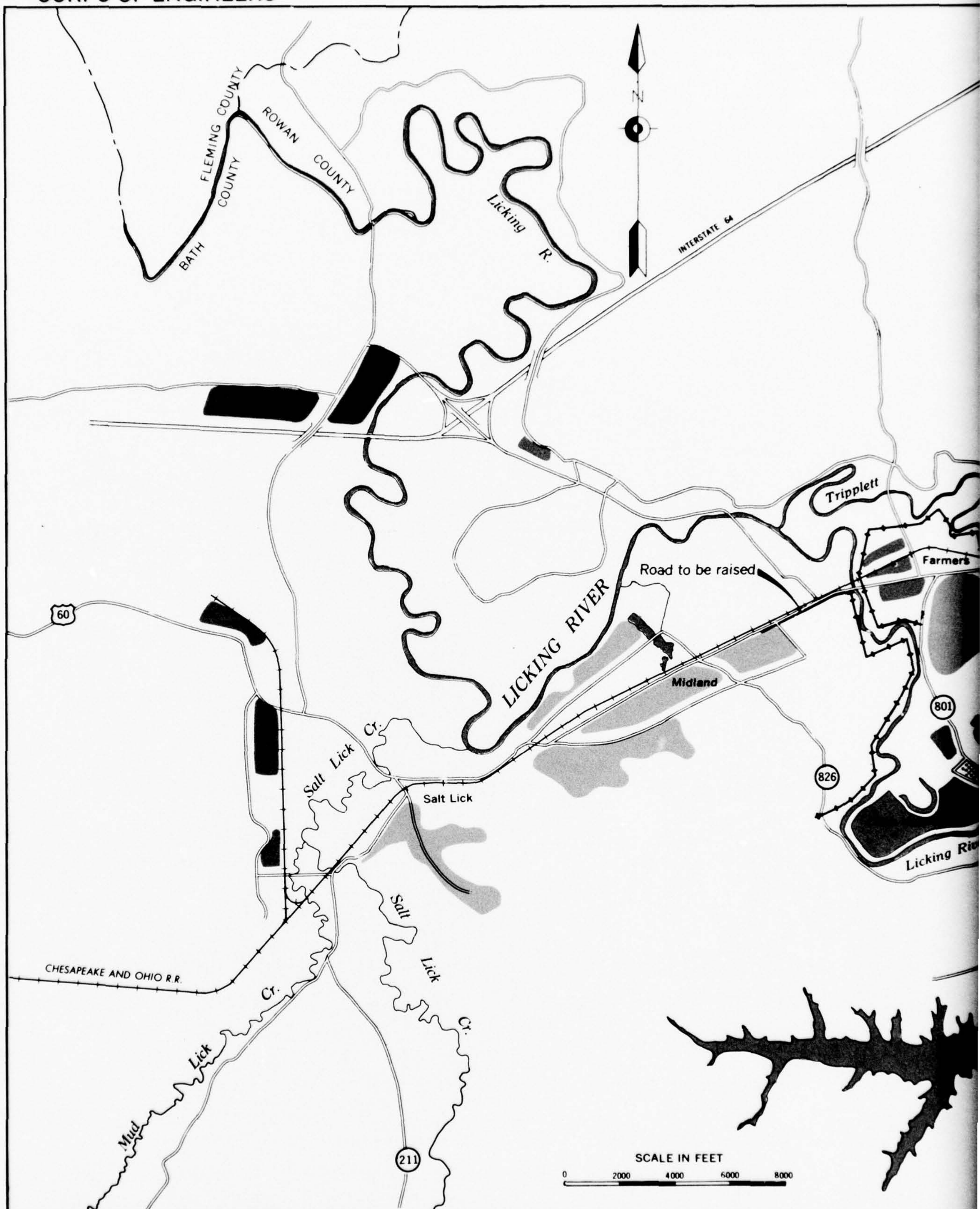
TABLE 16-4

SUMMARY OF INVESTMENT AND LAND NEEDS
BY PHASES FOR MIDLAND (CUMULATIVE)

Investment Category	1980 Invest. ($1,000)	1980 Land (acre)	2000 Invest. ($1,000)	2000 Land (acre)	2020 Invest. ($1,000)	2020 Land (acre)
Industrial	16,222	208	90,324	749	265,837	1,437
Commercial	6,700	57	23,673	201	44,666	379
Residential	16,563	389	65,664	1,538	142,676	3,252
Public & Quasi-Public	64,009	972	128,575	1,615	186,591	2,018
Total	103,494	1,626	308,236	4,103	639,770	7,086

Alternatives to Development - The Appalachian Regional Development Act of 1965 (PL 89-4) authorized an economic development program for the Appalachian Region. To meet the goals of this Act would require adoption of all feasible measures to stimulate and sustain economic growth within the region. This is true regardless of the methods employed to stimulate or create this economic expansion.

"No action" is always an alternative to "action". To take no action relative to development stimulation at Midland would be to forfeit an opportunity unique in Appalachia. There are several locational advantages making the Midland area ripe for development. There is a definite need for economic growth within the 9-county study area. A substantial labor force is available, either trained or trainable. Adequate transportation facilities will be available. There is a local organization to support development in this area and to sponsor an improvement plan. Perhaps the most important single locational advantage of the Midland area is the thousands of acres of under-developed level land which will be available for more productive use. Lack of level land is one of Appalachia Kentucky's principal problems. Also, the 9-county study area is located near the boundary of the Appalachian Region. This is a locational advantage, since persons moving into the newly-developed area would not be so far removed from social, cultural, educational and various other urban advantages which are essential for a viable development.


FLEMING COUNTY
BATH COUNTY
ROWAN COUNTY
Licking R.
INTERSTATE 64
N
Tripplett
Farmers
Road to be raised
LICKING RIVER
Midland
60
801
826
Salt Lick Cr.
Salt Lick
Licking Riv
Salt Lick Cr.
CHESAPEAKE AND OHIO R.R.
Mud Lick Cr.
211
SCALE IN FEET
0
2000
4000
6000
8000

LEGEND

YEAR			DEVELOPMENT
1980	2000	2020	
■	□	□	INDUSTRIAL
■	□	□	COMMERCIAL
■	□	□	RESIDENTIAL

—•—•—• PROPOSED LOCAL PROTECTION

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN APPALACHIAN REGION

MIDLAND, KENTUCKY
DEVELOPMENTAL PLAN — 1980

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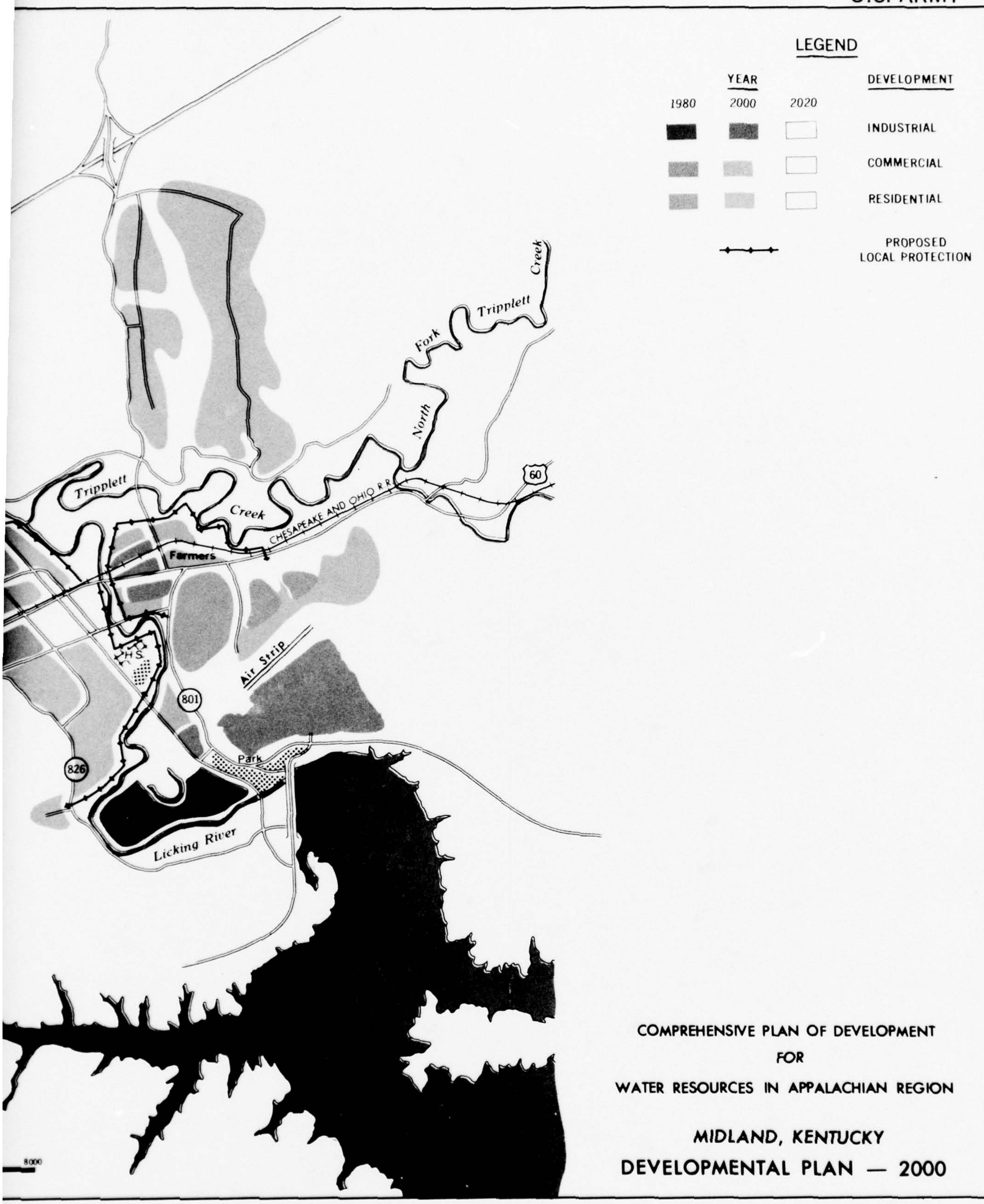

COMPREHENSIVE PLAN OF DEVELOPMENT

FOR

WATER RESOURCES IN APPALACHIAN REGION

MIDLAND, KENTUCKY

DEVELOPMENTAL PLAN — 2000

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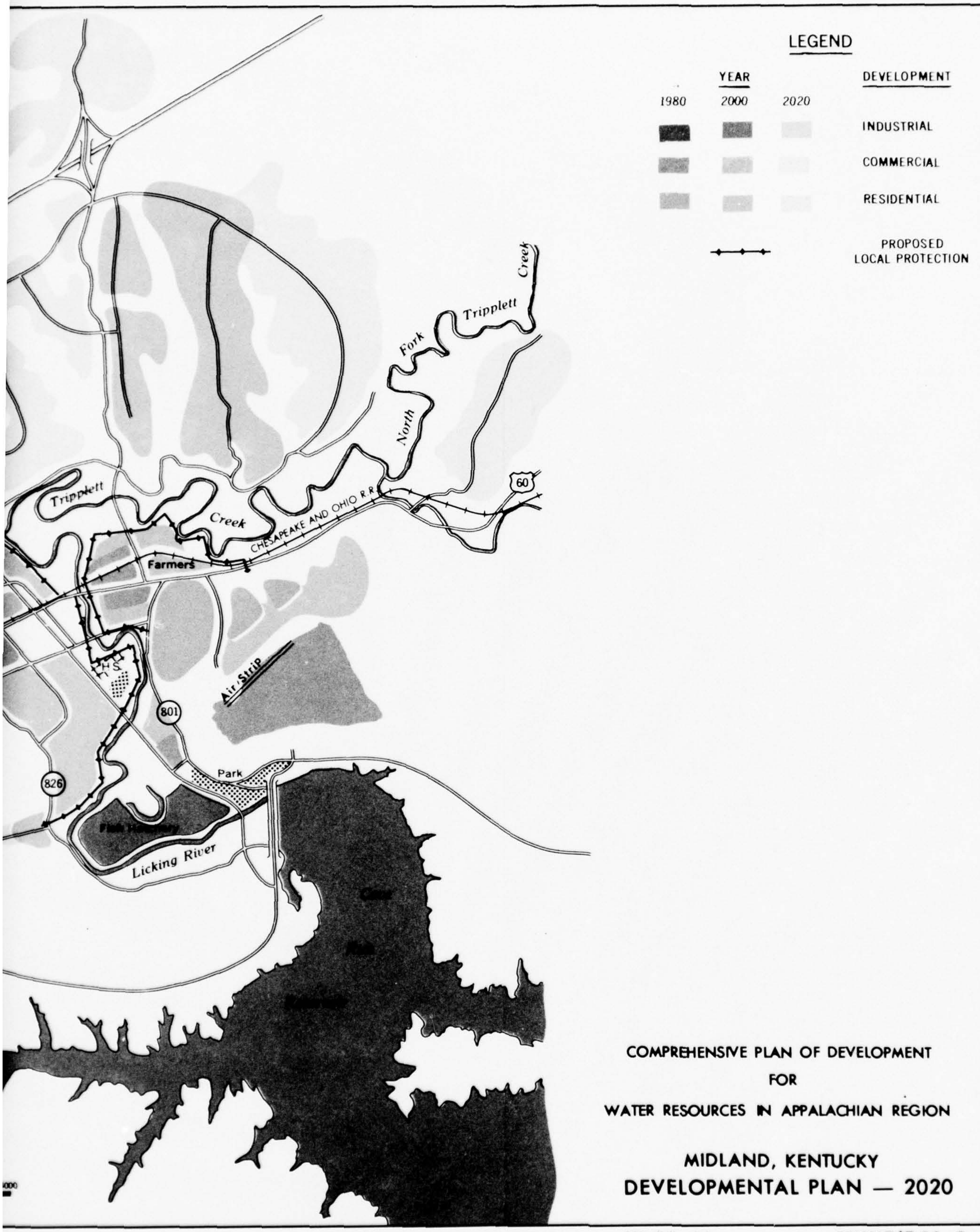

COMPREHENSIVE PLAN OF DEVELOPMENT

FOR

WATER RESOURCES IN APPALACHIAN REGION

MIDLAND, KENTUCKY

DEVELOPMENTAL PLAN — 2020

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Given these locational advantages it is apparent that a timely effort to structure a developmental plan at Midland should be made, in consonance with the goals of the Appalachian Regional Development Act.

6. LOCAL PROTECTION PROJECT FORMULATION

Located along the Licking River just below Cave Run damsite is an area containing approximately 21,000 acres which is topographically suitable for urban and industrial development. This area is relatively undeveloped due to frequent flooding from Licking River, and Triplett and Salt Lick Creeks. There are three small towns, Salt Lick, Midland, and Farmers, presently located along the Chesapeake and Ohio Railroad in this area, which will be referred to hereinafter as the "Midland area". The Midland area consists of about 12,100 acres in the flood plains of Licking River and Triplett and Salt Lick Creeks, 4,550 acres of flat ridgetop land, and 4,300 acres of moderately rolling but developable ridgetop land. This is a total of about 21,000 acres. After completion of Cave Run Reservoir and USDA structures only about 2,300 acres of the 12,100 acres of flat river bottom land would remain undevelopable due to flooding by Triplett and Salt Lick Creeks. Therefore, after completion of Cave Run Reservoir and the USDA structures, a total of 18,650 acres will be available for development without local protection. An immediate question then arises; why is it necessary to provide local flood protection to 2,300 acres of flood plain land when there are 18,650 acres in the vicinity that are not in the flood plain? The 2,300 acres needing additional flood protection comprises the heart of the "new town" as designed by Spindletop Research Center and the University of Kentucky's Institute for Environmental Studies. This planned community has been designed around separated industrial and commercial "hubs" with utility and environmental aspects placed in the first position. The configuration and location of developable tracts of land, the present highway and railroad net, and utility and environmental aspects dictate the location of the planned community's industrial and commercial centers. The community was then designed around these centers in such a way as to provide maximum utility with the most pleasurable urban environment possible. This design required use of the 2,300 acres of flood plain lands. While it is possible to develop a planned community excluding the 2,300 floodable acres, such a plan would have serious utility and environmental deficiencies and would not meet community planning criteria to create an efficient and viable development with a pleasing environment.

The Midland area lies along both banks of the Licking River from approximate river mile 161.0 to 172.0. Cave Run Reservoir (dam site mile 173.6) will control a drainage area of 826 square miles which is 99.3 percent of the total drainage area above the mouth of Triplett Creek which enters Licking River at mile 168.5 (See exhibits 16-1, 16-2, 16-3 and 16-4 in Section II).

The Midland area has been identified as the most suitable location for development of an industrial district and the attendant or supportive residential and commercial areas. This site is located in an area where land suitable for development is at a premium. Due to the rugged terrain most of the best land topographically favorable for development is situated in flood plains of principal streams.

Triplett Creek has a drainage area of 187 square miles. Flows from this basin are presently uncontrolled. The runoff characteristics of Triplett Creek are quite different from those of Licking River above the confluence. Flood discharges from Triplett Creek frequently exceed those from Licking River, resulting in reverse flow caused by backwater extending upstream in Licking River to the Cave Run damsite. Due to this condition, the Cave Run Reservoir only reduces the 100-year flood at the Farmers gage (Licking River mile 169.6) about 2 feet. With Cave Run Reservoir in operation a considerable portion of flood plain lands in the Midland area would still be susceptible to frequent flooding and the flood risk would remain too great to allow urban development of these lands.

Nineteen floodwater detention dams were considered in a study of Triplett Creek watershed conducted by the U.S. Department of Agriculture. This was a joint effort of Economic Research Service, Forest Service, and Soil Conservation Service all of the U.S. Department of Agriculture, and was made under authority of Section 206 of the Appalachian Regional Development Act of 1965. This study indicated that the 19 detention dams considered would reduce peak discharges of the 2-year, 10-year, and 100-year floods by about 27 percent at the mouth of Triplett Creek. Under authority of Public Law 566, the Soil Conservation Service has completed the work plan for the Salt Lick Creek watershed. Consideration has been given to six floodwater retarding structures and to channel improvements. The combined effect of these works would be to reduce peak flows at the mouth of Salt Lick Creek by approximately 23 percent. In addition USDA's recommended land treatment programs in the watersheds will improve the environmental quality of the area.

With Cave Run Reservoir and all 25 USDA retarding structures in operation the 100-year frequency flood would be reduced by an average of about 5 feet throughout the Midland area stream reach. However, a considerable portion of the Licking River flood plain in this reach would still be flooded on an average of 3 to 4 times per 100 years. This frequency of flooding would preclude urban development of these flood plain lands. Flood plain land accounts for about one third of the total land needed for the development plan as designed by the Spindletop Research Center and the University of Kentucky's Institute for Environmental Studies. If these lands are to be developed for industrial, commercial, and residential use, local flood protection is needed.

A development plan with no local flood protection works was studied by Spindletop Research Service in an effort to ascertain the need for fully exploiting the developmental potential of the Midland area. The

ultimate development will provide 24,000 primary jobs and allow for an investment of about 632,000,000 by 2020. By contrast, the development plan possible with no local protection works could provide only 9,600 primary jobs and allow an investment of about $244,000,000 by 2020. The full development potential of Midland must be exploited in order to raise the economy of the study area to a position comparable to that of the Nation. Therefore, it was concluded that local flood protection, in addition to that to be provided by Cave Run Reservoir and USDA structures, is needed.

Other water related needs expected to exist in the Midland area include water supply, water quality control and recreation. These needs can potentially be met by Cave Run Reservoir and the USDA structures. Other water resource problems are not applicable here.

7. ALTERNATIVES FOR MEETING FLOOD PROTECTION NEEDS

Possible ways to protect Midland's flood plain areas are by levees, channel improvements, flood retardation structures or a combination of these. Non-structural measures such as flood plain zoning would be beneficial in regulating future use of the flood plain. However, the objective at Midland is to foster development within the flood plain. Therefore, non-structural measures would not accomplish the total developmental objectives. A reservoir controlling Triplett Creek flows could provide the additional flood protection needed. However, U. S. Highway 60, Interstate Route 64, the Chesapeake and Ohio Railroad, pipelines, and the City of Morehead are located in Triplett Creek's flood plain. Because of relocation costs, a reservoir of the magnitude required to effectively control the Triplett Creek watershed would be less economically efficient than other alternatives.

A levee system with partial channel modification has been selected as the most practicable method of providing the high degree of local flood protection needed at Midland. Two levee plans were considered. One plan would protect only the portion of flood plain that is scheduled for development by 2020. Another plan would make available additional flood plain land for developmental uses. The cost of this second alternative would be approximately twice the cost of the first; whereas, benefits are approximately the same for both plans. Therefore levees providing protection for the development planned through 2020 would tend to maximize net project benefits.

The developmental plan described hereinafter was designed by the University of Kentucky's Institute for Environmental Studies with the assumption that local flood protection would be provided by a system of levees. Accordingly a levee system was designed to dovetail with the staged developmental plan. Based upon Appalachian criteria, this levee system is economically justified. It is recognized that a channel improvement plan sized to provide protection from a flood having a modified (USDA structures plus Cave Run Reservoir) exceedence frequency

of one occurance per 100 years may be a reasonable alternative to the selected levee system. A detailed analysis of such a plan should be accomplished during the advanced engineering and design stage of project development.

8. SELECTED PROJECT

The total plan for Midland can be described as possessing two elements. Element one consists of the recommended system of levees and channel improvement to be installed in three phases. These phases are keyed to three corresponding check points in a developmental plan which constitutes element two of the total selected plan. More specifically, element one consists of six sections of levee with appurtenances, one short section of flood wall, and one channel change. Element two consists of an industrial land-use and investment plan, a commercial land-use and investment plan, a residential land-use and investment plan, and a public and quasi-public land-use and investment plan. Pertinent data on the two elements of the selected plan are presented below.

Element One - When considering levee protection at Midland, certain assumptions were made. First, it was assumed that Cave Run Reservoir and all 25 USDA structures will be in operation by 1980. If this is not the case, minor changes in levee heights will be necessary. These changes can be effected during the advanced engineering and design stage. Secondly, it has been assumed that standard project flood protection should be provided. A high degree of flood protection is necessary in order to create an atmosphere conducive to urbanization of flood plain areas. As these flood plain areas, protected by levees, become more urbanized the consequences of levee overtopping becomes increasingly catastrophic. Not only does the threat to properties increase but the possibility of loss of life must be considered. Further, physical conditions peculiar to the Midland area, i.e. small elevation difference between the standard project and 100 year flood levels and wide flat valleys, make standard project flood protection at Midland more reasonable. Therefore, provision of standard project flood protection is deemed necessary and appropriate in this case. However, this degree of protection could be found impracticable and uneconomical in more limited valleys. Thirdly, no attempt to formally maximize net benefits has been made in this report. There are two reasons for this deviation from standard procedure. By inspection of the area it was obvious that any local flood protection at Midland would have to be justified by "developmental benefits" */ since a lack of user benefits was evident. The standard procedure of maximizing net benefits by varying the degree of protection provided is not considered applicable in this case since the relationship between various degrees of protection and developmental benefits realized is not susceptible to precise determination. Also, the degree of protection necessary was preconceived for the reasons discussed above. Since a high degree of protection is necessary in order to realize any developmental benefits

*/ Benefits will be defined in Section V of this Chapter.

and since a degree of protection higher than that necessary to allow development would create few additional benefits it is thought that standard project protection may approximate the point of maximum net developmental benefits.

The levee system presented herein has been designed as an element of a total development package. During design of this package complete consideration was given to aesthetics and other environmental factors.

The location and layout of the local flood protection project are shown on exhibit 16-1. Profiles and typical sections of all levee sections, the wall section, and the channel change are shown by phases on exhibit 16-9. Appurtenances of all units are also shown on these plates. Pertinent data for all units at Midland are presented in table 16-5.

The alignment of Levee Section Three is based on conditions after the Licking River channel change which is also a part of Phase III. Adoption of this provides an additional 50± acres of land for development and shortens the total length of this levee section. The new channel would have a 50-foot bottom width and 3 horizontal to 1 vertical side slopes.

Embankment material for the levee will be available from the channel excavation and from areas on the riverside of the levees. The flood protection plan will cumulatively protect approximately 775 acres in 1980, 1675 acres in 2000, and 2300 acres in 2020. Even though phasing the levees will have a zoning effect on the unprotected areas, zoning regulations will be necessary in order to assure orderly development.

Element Two - The developmental sketch plans discussed in a previous paragraph and shown on exhibits 16-2, -3, and -4 constitute element two of the total plan. This element is composed of four land-use and investment programs as discussed below.

a. Industrial Land-Use and Investment - The location and availability of prime industrial sites will play a critical role in improving Midland's economy. The projected potential employment level can be attained only if location advantages are utilized to the maximum extent. The assignment of lands for industrial use utilizes the ease of access to I-64 and to a proposed industrial spur line of the Chesapeake and Ohio Railroad.

The extent and magnitude of industrial development necessary to meet the developmental goal as determined from analysis of a fair share of regional production is defined by the land acreage and investment requirements discussed below. Phasing of industrial investments and land requirements are based on potential manufacturing employment and output forecasts by eleven 2-digit Standard

Industrial Classification (S.I.C.) Code groups derived by Spindletop Research. Considerable diversification exists within each of the eleven 2-digit groups. These diversifications are identified by 4-digit S.I.C. Classifications. A list of 133 4-digit industries was selected to obtain a reasonable profile of the characteristics of the types of manufacturing industries which might locate at Midland. Results of the summarized potential industrial land and investment needs are presented in table 16-6.

TABLE 16-6

POTENTIAL INDUSTRIAL INVESTMENT AND LAND REQUIREMENTS

Development Period Ending	Industrial Land Area (Acres)	Total Land and Improvement Costs ($1,000)	Total Plant and Equipment Costs ($1,000)	Total Industrial Investment ($1,000)
1980	208	759	15,463	16,222
1990	506	1,847	46,898	48,745
2000	749	2,734	87,590	90,324
2010	1,040	3,796	154,475	158,271
2020	1,437	5,245	260,592	265,837

b. Commercial Land-Use and Investment - The purpose and location of the various types of commercial development programmed for Midland are, generally, self-explanatory. They are as follows:

The Central Business District, consisting of wholesale establishments, business and professional offices, and convenience and specialty shops, will be the focal point of Midland's central area.

Neighborhood Shopping Centers will increase and expand with Midland's population and will be located throughout the Midland area.

Highway-Serving Areas will arise from the growth of the resident Midland population and the growth of Cave Run Reservoir, Daniel Boone National Forest, and Falmouth Reservoir recreation facilities, in conjunction with the traffic market offered by I-64.

TABLE 16-5
PERTINENT DATA-ELEMENT ONE

Levee Section	Avg. Ht. (feet)	Gross Length (feet)	Pumping Plants	Transportation Facilities 1/ Ramps	Transportation Facilities 1/ Closures	Grade Elevation (msl) Lower End	Grade Elevation (msl) Upper End
PHASE I							
One 2/	12	12,300	1	1	0	682	682
Five	14	12,700	2	3	2	682	685
Subtotals	Levee	25,000	3	4	2		
PHASE II							
Two	13	10,300	1	0	1	676	682
Four	14	7,500	1	0	0	673	674
Six	14	9,450	1	2	2	675	675
Wall 3/	14	250	-	-	-	675	675
Subtotals	Levee	27,250	3	2	3		
	Wall	250					
PHASE III							
Three	18	7,400	1	0	0	673	674
Channel Change	19 (cut)	1,500	-	-	-	630	630
Subtotals	Levee	7,400					
	Channel	1,500	1	0	0		
TOTALS	Levee -	59,650					
	Channel-	1,500	7	6	5		
	Wall	250					

1/ Based on the existing transportation system.
2/ In connection with Levee Section One, 4,200' of U. S. 60 must be raised an average of 3 feet.
3/ This wall section is located alongside the business district protected by Levee Section Six.

Hospitality and Recreation Centers programmed near I-64 will include hotel-motel accommodations, automobile services, and tourist service activities. Almost exclusively, this development will be dependent upon tourist demand and the level of industrial development.

A Regional Shopping Center is proposed to serve the nine-county area surrounding Midland. A location near I-64 would provide the advantages of major expressway frontage.

Commercial space and investment requirements for retail service and wholesale trade are based on estimated dollar volume of sales forecast for the Midland area. As the community grows and facilities are added, its importance as a regional trade center will also grow. Additional sales generated from purchases of goods and services by people living in outlying areas will significantly affect the volume of retail and service trades. For purposes of this report, it is assumed regional trade will increase Midland's retail and service sales by 16 percent (including sales generated by university and tourist spending). Wholesale trade sales as a percent of retail and service trade sales have remained steady for the State of Kentucky. It is presumed this ratio (90.2% to 90.7%) would apply to developing wholesale establishments at Midland during the period 1980 through 2020. Resulting projections appear in table 16-7.

TABLE 16-7

POTENTIAL COMMERCIAL FACILITIES, LAND AND INVESTMENT REQUIREMENTS AT MIDLAND (CUMULATIVE)

Characteristic	1980	1990	2000	2010	2020
Total Trade Sales ($1,000)	22,048	47,004	75,996	104,795	144,231
Percent	15.0	33.0	53.0	73.0	100.0
Total Leasable Floor Area (Sq. Ft)	591,200	1,300,600	2,088,800	2,877,100	3,941,200
Total Land Area (Acres)	57	125	201	277	379
Total Investment (land, buildings and improvements) ($1,000)	6,700	14,740	23,673	32,606	44,666

c. Residential Land-Use and Investment - Residential development in the Midland area has been curtailed because of an undeveloped economy that has failed to provide employment and retain population, which is a common problem throughout much of the Appalachian Region. Planned public investment and induced industrial development are expected to arrest this problem and contribute to an increased demand for residential development in the project area. During the first stages of development the flat lands of the lower flood plain are required for the larger per unit acreage need of industrial, commercial, and public development; whereas residential expansion needs will be fulfilled, generally speaking, by those areas bordering along the upper limits of the flood plain, and the ridgetop land. Until such time as Midland can support high density housing, the flood plain areas close to the central business district will remain unprotected in order to prevent commercial or low density residential developments from occupying sites which could best be put to high density residential use in later stages of development.

Projections of residential land and investment needs were phased in consonance with industrial and public employment demands. The resulting phased investment and land use requirements are presented by density in table 16-8.

d. Public and Quasi-Public Land-Use and Investment - It is estimated that the expansion of industrial jobs and a subsequent population increment in the Midland area will call for substantial increases in public facilities in addition to specifically planned public institutions. There are six basic types of facilities on which new development can be expected to have a major impact. These include schools, health facilities, urban service facilities, regional service facilities (federal and non-federal), transportation, and utilities. The total public investment (including utility company investments) required to help bring about the forecast level of employment and private investment is estimated at approximately $187 million by 2020. This figure includes land acquisition, land improvement costs, building construction, and equipment.

The magnitude of land and investment projections is a direct function of population and projected private development. Standard relationships between population and the various public facility units */ were used in deriving phased public development, land needs and investment. The resulting land and investment requirements are presented in tables 16-9 and 16-10, respectively.

*/ Standard units refer to hospital beds per 1,000 population, number of fire stations per 1,000 population, land requirements per public unit, etc.

TABLE 16-8

RESIDENTIAL DEVELOPMENT AND INVESTMENT
AT MIDLAND

Density 1/	Dwelling Unit Type 2/	Ultimate Number of Dwelling Units 3/	Total Investment ($1,000) 4/ 1980	1990	2000	2010	2020
Low density							
0.86	SF	244	936	2,153	3,494	5,179	7,613
1.13	SF	850	2,951	6,800	11,015	16,270	23,885
1.65	SF	789	2,425	5,600	9,075	13,425	19,725
2.16	SF	850	2,195	5,058	8,193	12,101	17,765
3.16	SF	3,347	6,938	16,010	25,889	38,287	56,230
High density							
6.00	MF	1,040	1,118	2,408	4,644	5,934	8,944
15.00	MF	690	-	1,290	3,354	4,644	5.934
30.00	MF	300	-	-	-	1,290	2,580
TOTAL		8,110	16,563	39,319	65,664	97,130	142,676
Total Land Acreage Needs			389 Ac.	901 Ac.	1,538 Ac.	2,232 Ac.	3,252 Ac.

1/ Gross density dwelling units per gross land acre
2/ SF = single family, MF = multiple family
3/ Total expected units in 2020
4/ Cumulative figures

TABLE 16-9

PUBLIC AND QUASI-PUBLIC LAND REQUIREMENTS

Land-Use Category	Cumulative Land Requirements by Decade (Acres) 1980	1990	2000	2010	2020
Elementary Schools	20	36	53	71	95
High Schools	7	13	20	26	35
University	230	230	230	230	230
Fire Protection	2	2	3	4	5
General Recreation	57	100	160	210	300
Golf Course	150	150	150	150	150
Flood Protection	72	72	161	161	195
Sewer and Water	10	12	15	18	20
Retardation Center	40	40	40	40	40
Hospital	8	14	23	30	42
Public Buildings					
Local	5	10	16	22	30
State	4	9	14	21	29
Federal	6	12	19	26	36
Highways	150	210	300	340	400
Railroads	11	11	11	11	11
Airport	-	200	200	200	200
Fish Hatchery	200	200	200	200	200
TOTAL	972	1,321	1,615	1,760	2,018
Tourist Recreation 1/	1,000	1,200	1,375	1,375	1,375

1/ Land acreage for tourist recreation has been set aside by U. S. Forest Service and U. S. Army Corps of Engineers in connection with the Cave Run Reservoir. As such, this land is not a net addition to the developmental plan acreage requirements.

e. Development Plan Summary - The development plan will have a substantial impact on the nine-county study area's economy. Potential investment by 2020 for industrial, commercial, residential, and public and quasi-public purposes amounts to $639,770,000. Total land needs for intensive development amounts to 7,086 acres. Table 16-11 summarizes investments and land needs of the development plan by decades.

TABLE 16-10

POTENTIAL INVESTMENT IN THE PUBLIC
AND QUASI-PUBLIC PLAN ($1,000)

PUBLIC FUNCTION	1980	1990	2000	2010	2020
Education					
Elementary Schools	1,060	1,878	2,819	3,773	5,045
High School	291	534	795	1,038	1,410
University	15,396	24,116	31,393	37,238	41,749
Subtotal	16,747	26,528	35,007	42,049	48,204
Health					
Hospital	2,184	3,822	6,117	8,028	11,466
Retardation Center	17,240	18,964	20,860	22,946	25,241
Subtotal	19,424	22,786	26,977	30,974	36,707
Urban Services (local)					
Public Buildings	954	2,019	3,299	4,490	6,280
Recreation	314	550	880	1,155	1,650
Golf Course	255	435	435	435	435
Sewer and Water	2,151	4,437	7,125	9,545	13,444
Fire Protection	156	156	234	312	390
Flood Protection	2,640	2,640	6,780	6,780	8,230
Subtotal 1/	6,470	10,237	18,753	22,717	30,429
Regional Services (State)					
Public Buildings	922	1,953	3,016	4,346	6,077
Fish Hatchery	600	600	600	600	600
Subtotal	1,522	2,553	3,616	4,946	6,677
Regional Services (Federal)					
Public Buildings	1,200	2,539	4,038	5,649	7,900
Recreation-Forest Service	10,073	14,874	18,638	20,249	22,500
Subtotal	11,273	17,413	22,676	25,898	30,400
Transportation and Utilities					
Highways	6,090	8,770	12,650	15,050	18,190
Airport	0	1,350	1,350	1,350	1,350
Rail Feeder Line	240	240	240	240	240
Utilities	2,243	4,491	7,306	10,422	14,394
Subtotal	8,573	14,851	21,546	27,062	34,174
TOTAL INVESTMENTS 1/	64,009	94,368	128,575	153,646	186,591

1/ Includes cost of local protection project.

TABLE 16-11

SUMMARY OF INCREMENTAL INCREASES
IN INVESTMENT AND LAND NEEDS

Investment Category	By 1980		1981-1990		1991-2000		2001-2010		2011-2020		Total	
	Inv. ($1,000)	Land (Ac.)	Inv. ($1,000)	Land (Ac.)	Inv. ($1,000)	Land (Ac.)	Inv. ($1,000)	Land (Ac.)	Inv. ($1,000)	Land (Ac.)	Inv. ($1,000)	Land (Ac.)
Industrial	16,222	208	32,523	298	41,579	243	67,947	291	107,566	397	265,837	1,437
Commercial	6,700	57	8,040	68	8,933	76	8,933	76	12,060	102	44,666	379
Residential	16,563	389	22,756	512	26,345	637	31,466	694	45,546	1,020	142,676	3,252
Public and Quasi-Public	64,009	972	30,359	349	34,207	294	25,071	145	32,945	258	186,591	2,018
Total	103,494	1,626	93,678	1,227	111,064	1,250	133,417	1,206	198,117	1,777	639,770	7,086

Adequacy - Element one (the flood control project) will provide standard project flood protection for areas in the developmental plan subject to flooding, thus allowing this land to be intensively developed. Element one satisfies the flood protection needs of the area at a minimum cost.

Developmental benchmarks were derived by the Office of Appalachian Studies and the Office of Business Economics as guides to overall planning processes for the Appalachian Survey. These benchmarks are intended to show how much growth is needed within an area to bring that area closer to national growth trends and achievements, and by so doing they represent goals for economically depressed areas. The developmental plan's performance relative to the benchmark projections and to projections based on historical trends can be measured by comparing plan-occasioned projections of population, employment, and population per employee ratios with benchmark and historical trend projections of like parameters. The plan's performance relative to historical trend projections is a measure of its impact upon the study area. Measurement of this impact is further enhanced by quantifying plan-occasioned wages within this area.

Comparisons of population, employment, and population per employee ratios are shown graphically on figures 16-6, -7, and -8.

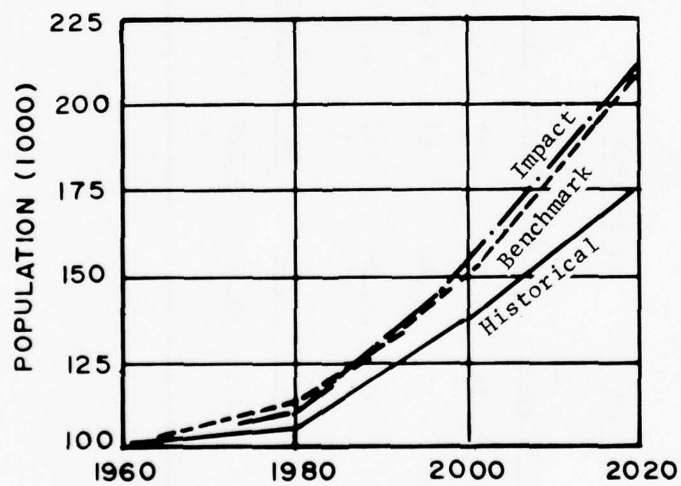

Figure 16-6. Comparison of Population Increases Within the Study Area.

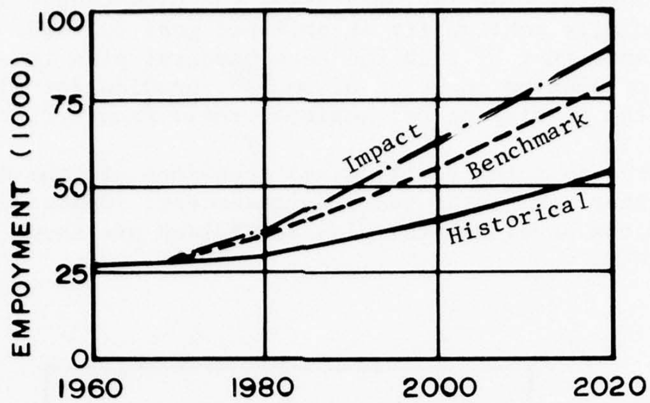

Figure 16-7. Comparison of Employment Increases Within the Study Area.

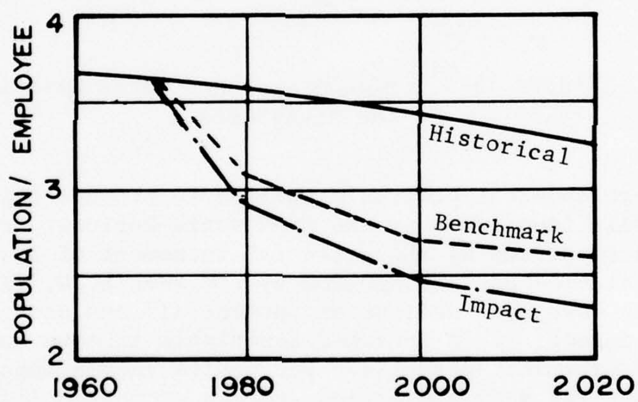

Figure 16-8. Comparison of Population Per Employee Ratio Within the Study Area.

These figures indicate that total employment and the population per employee ratio exceeds the developmental benchmarks by 2020. Thus with developmental plan implementation the nine-county area's economy would essentially achieve its established goal by 2020. Figures 16-6, -7, and -8 show that by 2020 the developmental plan is expected to occasion a population increase of 36,900, provide for 35,600 new jobs, and reduce the population per employee ratio from 3.25 to 2.30.

Increases in total yearly wages occasioned by the developmental plan is another measure of the plan's success. Wages expected to result from the developmental plan at Midland are shown graphically on figure 16-9.

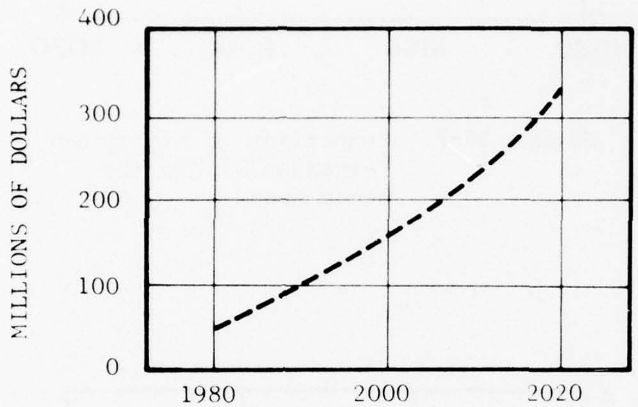

Figure 16-9. Plan-Occasioned Wages Within the Study Area.

The developmental program's ability to produce desired economic changes (goals identified by the Appalachia Regional Development Act of 1965) is supported by the potential increment of 35,570 jobs and wages and salaries of $325,650,000 by the year 2020. Inasmuch as these values have been defined as "potential" and used as a measurement of project impact, it is presumed acceptable to move one step further and estimate "potential" per capita income impact. It is realized that the many and varied sources of income limit the degree of accuracy by which per capita income can be adjusted to reflect program impact; however, by working with aggregates and utilizing data employed for the area's economic base study, an equally reliable estimate can be derived. The impact on population defined previously is used for this calculation. Historic projected aggregate income was derived by multiplying historic-projected per capita income times historic-projected population. The increment in aggregate income occasioned by the wages and salaries shown in table 16-39 was added to obtain impact aggregate income. Wages and salaries were adjusted

to 1954 dollars (for use with OBE projections) and increased by a factor of 1.493 1/ to reflect the fact that wages and salaries account for approximately 67 percent of personal income. A number of methods were attempted, each requiring different assumptions (with conservatism being the theme) and each resulting in closely related values. Comparison of pertinent historical and projected per capita incomes are shown of figure 16-10.

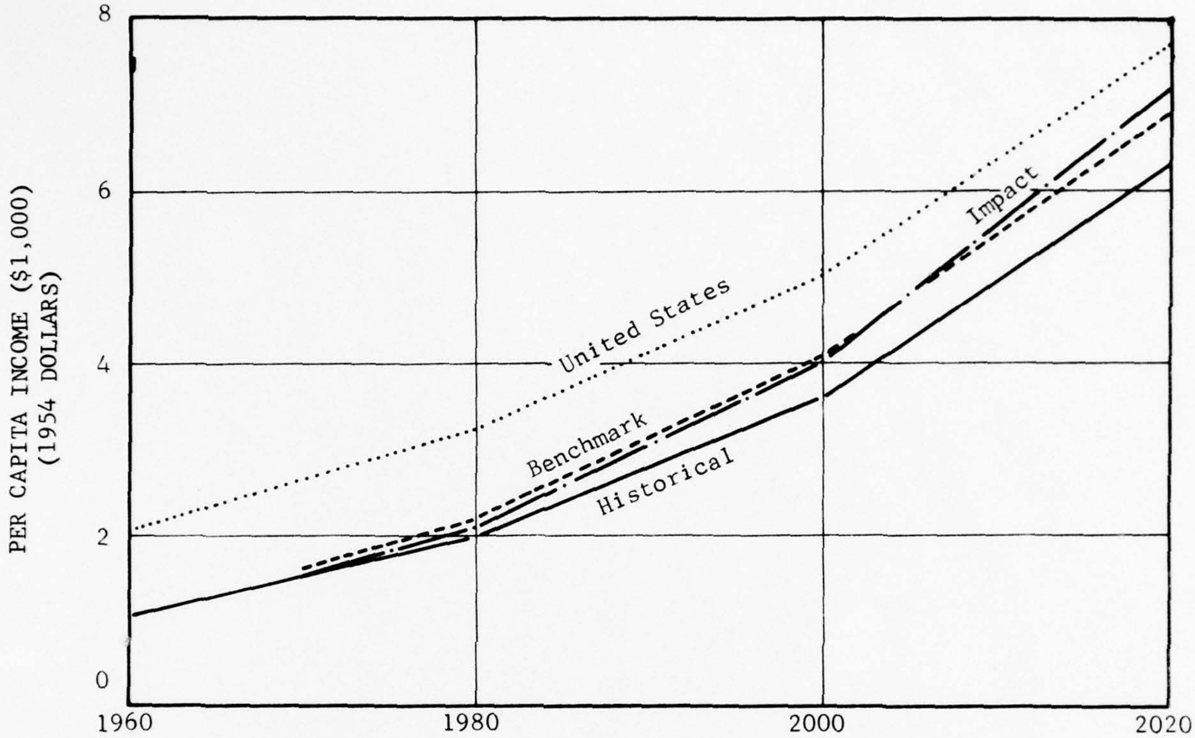

Figure 16-10 Comparison of Per Capita Incomes (1954 dollars) (Study Area and United States)

Figure 16-10 indicates that per capita income within the 9-county study area would increase from about $1,400 in 1970 to $7,060 in 2020 and would exceed the benchmark by the year 2004. By 2020 the developmental plan would increase per capita income within the study area by about $750.

The local protection and developmental plans have been designed to provide long term benefits to the nation and region. Public monies expended for these works would accelerate a substantial private investment which would in turn stimulate economic growth in the study area.

1/ 100%/67% = 1.493, 67% used as average for projection based on data from the Biennial Supplement to the Survey of Current Business page 203, 1967 edition.

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SECTION III - DESIGN CONSIDERATIONS

9. HYDROLOGIC

The hydrologic study area covers the Licking River flood plain from Morre's Ferry (mile 154.6) to the Cave Run damsite (mile 173.6), plus the lower reaches of Triplett and Salt Lick Creeks. Effects of floodwater retarding structures investigated by the U. S. Department of Agriculture (USDA) in Triplett and Salt Lick Creek watersheds have been considered.

The climate at Midland is considered moderate, with an average annual temperature of about 56 degrees and precipitation of about 45 inches. Average temperature in January is about 35 degrees and in July, 77 degrees. Approximately 25 days per year the temperature reaches or exceeds 90 degrees and about 100 days, 32 degrees or below. Monthly precipitation is fairly well distributed, with the maximum, about 5 inches, in July and the minimum, about 2 inches, in October. Average snowfall is about 15 inches and snowpack accumulation is not considered to be a significant flood-producing factor.

The Cave Run Dam, presently under construction, is located about 1-3/4 miles south of Farmers, Kentucky. The drainage area at the damsite is 826 square miles, which controls 99.3 percent of the drainage area above Triplett Creek, and 22.3 percent of the Licking River Basin. Detailed information on the Cave Run Dam and Reservoir may be obtained from the Cave Run Reservoir Design Memorandum (Louisville District).

Nineteen proposed detention dams were considered in a project formulated by the USDA for the Triplett Creek Watershed. Reductions in peak discharge averaged approximately 27 percent at the mouth of Triplett Creek for the 2-, 10-, and 100-year floods. A similar project, consisting of six structures in the Salt Lick Creek Basin, also resulted in approximately 23 percent reduction in peak flows at the mouth of that stream.

<u>Pertinent Floods of Record</u> - Streamflow records of Triplett Creek at Morehead, 13.5 miles above its mouth, have been kept since 1941, and those at Farmers on the Licking River, 1.1 miles upstream of Triplett Creek, are considered accurate since 1938. The five highest floods at each station through 1966 are listed in table 16-12 below which gives the date, peak discharge, and peak stage of each flood.

TABLE 16-12

RECORDED FLOOD DATA

Triplett Creek at Morehead, Ky.

(Datum of Gage is 708.26 ft. above msl)*

Date	Peak Discharge	Peak Stage
21 Sep 1950	11,400 cfs	13.10
9 Jul 1955	11,000	13.00
3 Jul 1960	18,600	14.83
11 Mar 1963	10,300	12.75
18 Apr 1964	10,300	12.76

Licking River at Farmers, Ky.

(Datum of Gage is 646.55 ft. above msl)*/

Date	Peak Discharge	Peak Stage
14 Apr 1948	14,900 cfs	25.60
1 Feb 1950	21,300	26.31
22 Sep 1950	14,000	25.45
5 Mar 1955	14,500	25.65
28 Feb 1962	24,000	26.70

*/Datum of 1929 General Adjustment.

The two major floods described in the succeeding paragraphs are among those listed in the above tabulation for Morehead, but do not appear in the list of major floods at Farmers. These two floods, September 1950 and July 1960, were estimated to be the highest of record (1941-1966) in terms of peak discharge in the reach of Licking River immediately downstream of Triplett Creek. This reach comprises the largest portion of the hydrologic study area. An analysis of comparative flood records for the two gaging stations and the USDA relationship of discharges at the mouth of Triplett Creek to discharges at Morehead indicate a substantial percentage of the greatest floods below Farmers result from storms centered over the Triplett Creek Basin.

a. September 1950 Flood - The flood of September 1950 produced an estimated peak discharge of 32,000 cfs below the confluence of Licking River and Triplett Creek. The recorded peak flows at the Farmers and Morehead gaging stations, respectively, were 14,000 cfs and 11,400 cfs.

b. July 1960 Flood - The flood of 3 July 1960 was primarily caused by heavy rains and rapid runoff from the Triplett Creek Basin.

The peaks at Farmers and Morehead, respectively, were 7,400 cfs and 18,600 cfs (highest of record). Below the confluence, the estimated peak flow of the Licking River was 36,400 cfs.

Natural Flow-Frequency, Licking River at Farmers - The period of record covered by the Farmers frequency study is October 1938 through September 1966. The natural flow-frequency was based on peak annual flows with a skew coefficient of zero, and partial-duration peaks above the base of 7,000 cfs. The method used is described in "Statistical Methods in Hydrology" by Leo R. Beard, January 1962.

Natural Flow-Frequency, Triplett Creek at Mouth - Data received from the USDA study on flood-control structures in the Triplett Creek Basin were used to construct a natural flow-frequency curve for Triplett Creek at its mouth.

Natural Flow-Frequency, Licking River below Mouth of Triplett Creek - The USDA flood routing study provided peak discharge values for the Triplett Creek at Morehead gaging station and for Triplett Creek at the mouth for hypothetical 2-year, 10-year, and 100-year floods. A curve relating these peak flows at Morehead to the corresponding peaks at the mouth was constructed on logarithmic paper and was found to conform nearly to a straight line. This provided for extrapolation to higher and lower discharges with a small margin of error. Figure 16-11 shows plot of these values.

The indicated travel times of the peaks from Morehead to the mouth were approximately 6 hours for each of the three floods. Given this lag-time and peak discharge relationship, values could be estimated for Triplett Creek at the mouth for any flood of record in which the peak discharge and time were known at Morehead. For example, the observed peak of the April 9, 1942 flood at Morehead was 7330 cfs at 2 P.M. From the above-described curve, a corresponding peak of 13,000 cfs at the mouth was obtained. This derived peak was assumed to occur at 8 P.M. on April 9th.

In order to compute annual peak flows for Licking River below Triplett Creek, it was necessary to compare the annual peaks for the gaging station at Farmers with the combined events resulting from the addition of peak Triplett Creek outflows and simultaneous observed flows at Farmers which were derived from plotted discharge hydrographs. Each flood period considered to have a chance of producing a combined annual peak discharge greater than the published Farmers peak in a particular water year was investigated. Referring again to the April 1942 flood, the peak discharge at the Farmers gage of 10,200 cfs occurred at 6 P.M. on the 10th. The instantaneous Farmers flow at the estimated time of the peak of the Triplett Creek outflow (8 P.M. on the 9th) was only 3200 cfs. Thus, the combined peak below the confluence at this time was 13,000 + 3200, or 16,200 cfs, and is shown graphically on Figure 16-12. This occurrence proved to be the highest peak of the 1942 water year.

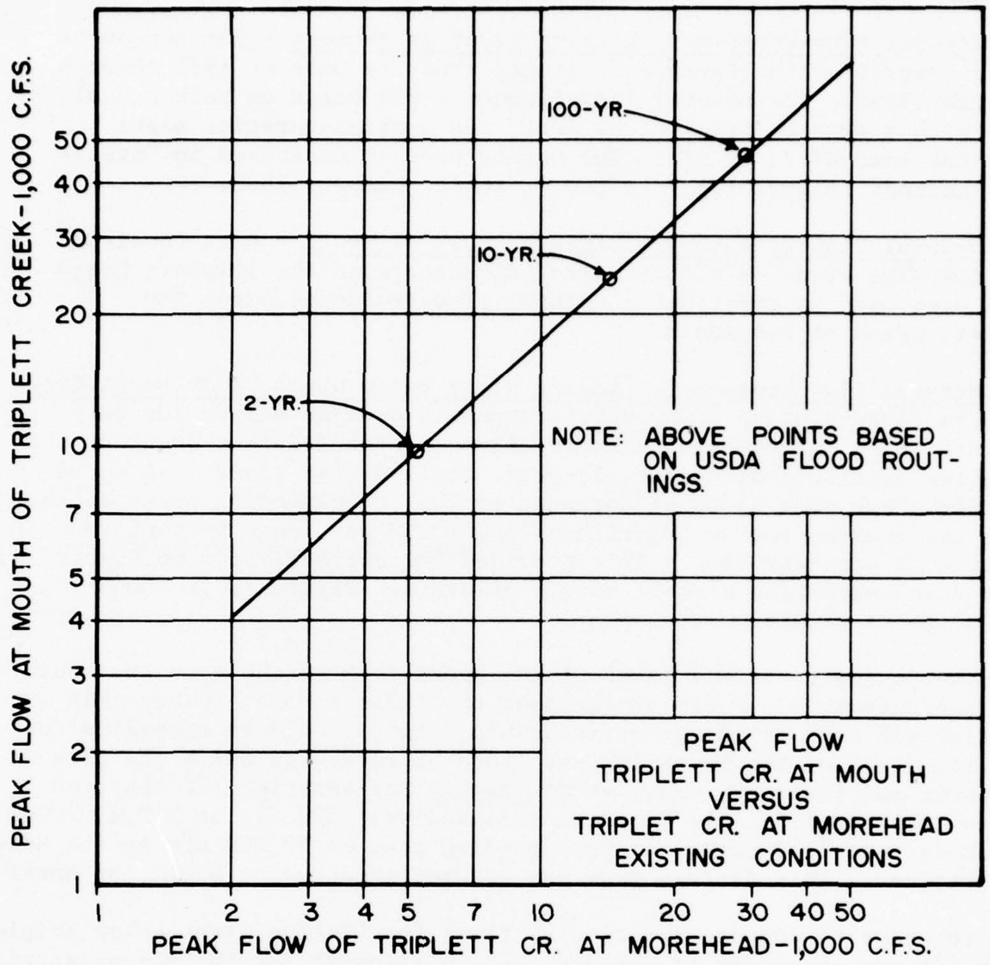

PEAK FLOW AT MOUTH OF TRIPLETT CREEK-1,000 C.F.S.
PEAK FLOW OF TRIPLETT CR. AT MOREHEAD-1,000 C.F.S.
1
2
3
4
5
7
10
20
30
40
50
100-YR.
10-YR.
2-YR.
NOTE: ABOVE POINTS BASED ON USDA FLOOD ROUTINGS.
PEAK FLOW
TRIPLETT CR. AT MOUTH
VERSUS
TRIPLET CR. AT MOREHEAD
EXISTING CONDITIONS

FIGURE 16-11

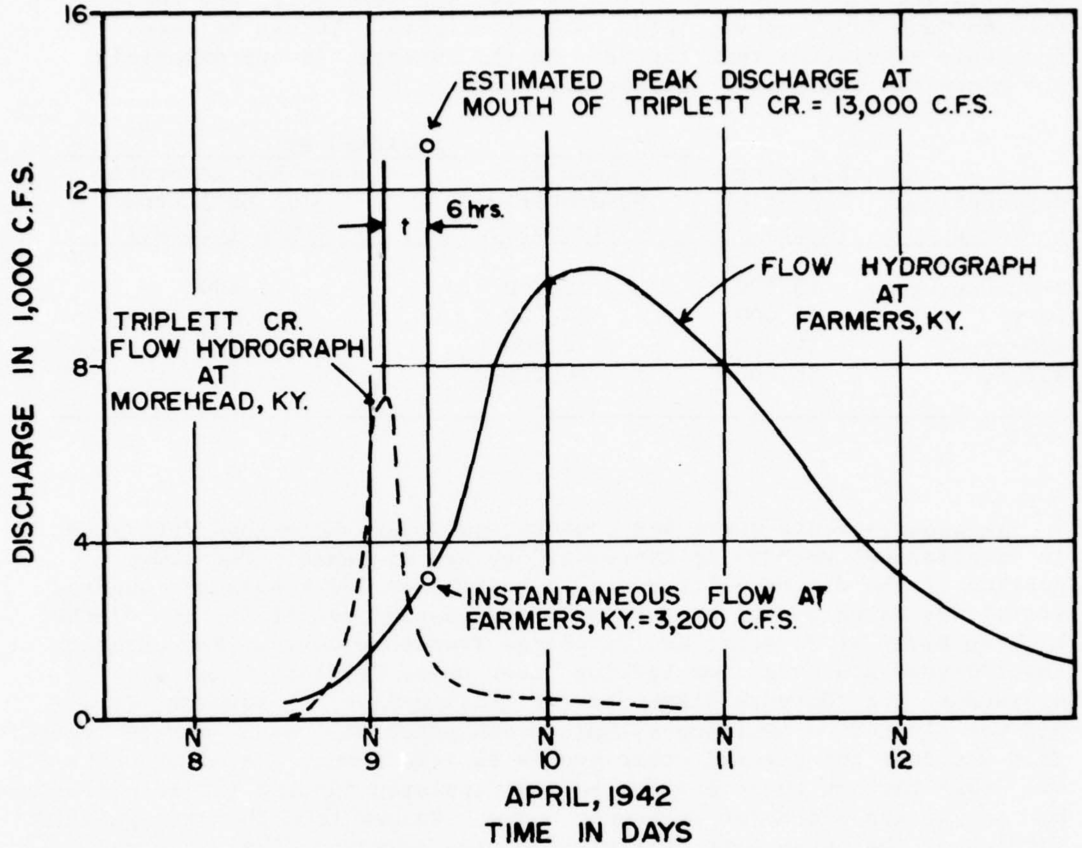


FIGURE 16-12 ANNUAL PEAK FLOWS FOR LICKING RIVER BELOW TRIPLETT CREEK

Tabulated below are the three frequency and SPF peak discharges for existing conditions, modified by Cave Run Reservoir, and modified by Cave Run Reservoir plus USDA structures. It can be seen from this tabulation that the SPF, on the average, is approximately 1.5 times the 100-year frequency discharge.

Hypothetical Flood	Existing Condition (c.f.s.)	Modified by: Cave Run Reservoir only (c.f.s.)	Modified by: Cave Run Reservoir plus USDA structures (c.f.s.)
2-Yr.frequency	18,500	10,000	7,400
10-yr. "	31,600	24,300	18,000
100-yr. "	54,500	46,900	34,600
S.P.F.	86,600	60,200	44,700

An annual-events curve was constructed using the method described in "Statistical Methods in Hydrology" by Leo R. Beard. The lower portion of the discharge frequency curve (10 to 100 events per hundred years) was based on the proportion of the annual events portion of the Licking River at Farmers, Ky. discharge frequency curve. For example, the 100-year discharge for Licking River below Triplett Creek was divided by the 100-year discharge for Licking River at Farmers, Ky., and was plotted on semi-logarithmic graph paper at 1 event per 100 years. This was done for several other events in like manner. A smooth curve was drawn through these points, and extrapolated through the more frequent portion of the discharge frequency curve. Values from the extrapolated portion of the curve were multiplied by the corresponding discharge values of the Licking River at Farmers, Ky. in order to determine value for the Licking River below Triplett Creek discharge frequency curve.

Natural Flow-Frequency at Hypothetical Gages - Two hypothetical gages, at mile 163.0 and at mile 167.0 on the Licking River were chosen. It was decided that only a minimal error would be introduced if the natural flow-frequencies at these two sites were made equal to the natural flow frequency for Licking River below its confluence with Triplett Creek. Tendencies of tributary and local inflows to increase the peak as the flood wave travels downstream were considered to be offset by the effects of storage in the rather wide flood plain area.

Flow-Frequency Modified by Cave Run Reservoir Only - A constant minimum release of 200 cfs from Cave Run Reservoir was assumed for all modified floods studies. Therefore, all Licking River peak flows below Triplett Creek would be equal to Triplett Creek peak outflows plus 200 cfs.

Flow-Frequency Modified by Cave Run plus USDA Structures - Modified peak discharges at the mouth of Triplett Creek, with proposed flood control structures in operation, were furnished by USDA for 2-, 10-, and 100-year frequencies. The resulting frequency curve would then apply to the Licking River downstream of Triplett Creek with the addition of 200 cfs to all flows (Cave Run minimum release).

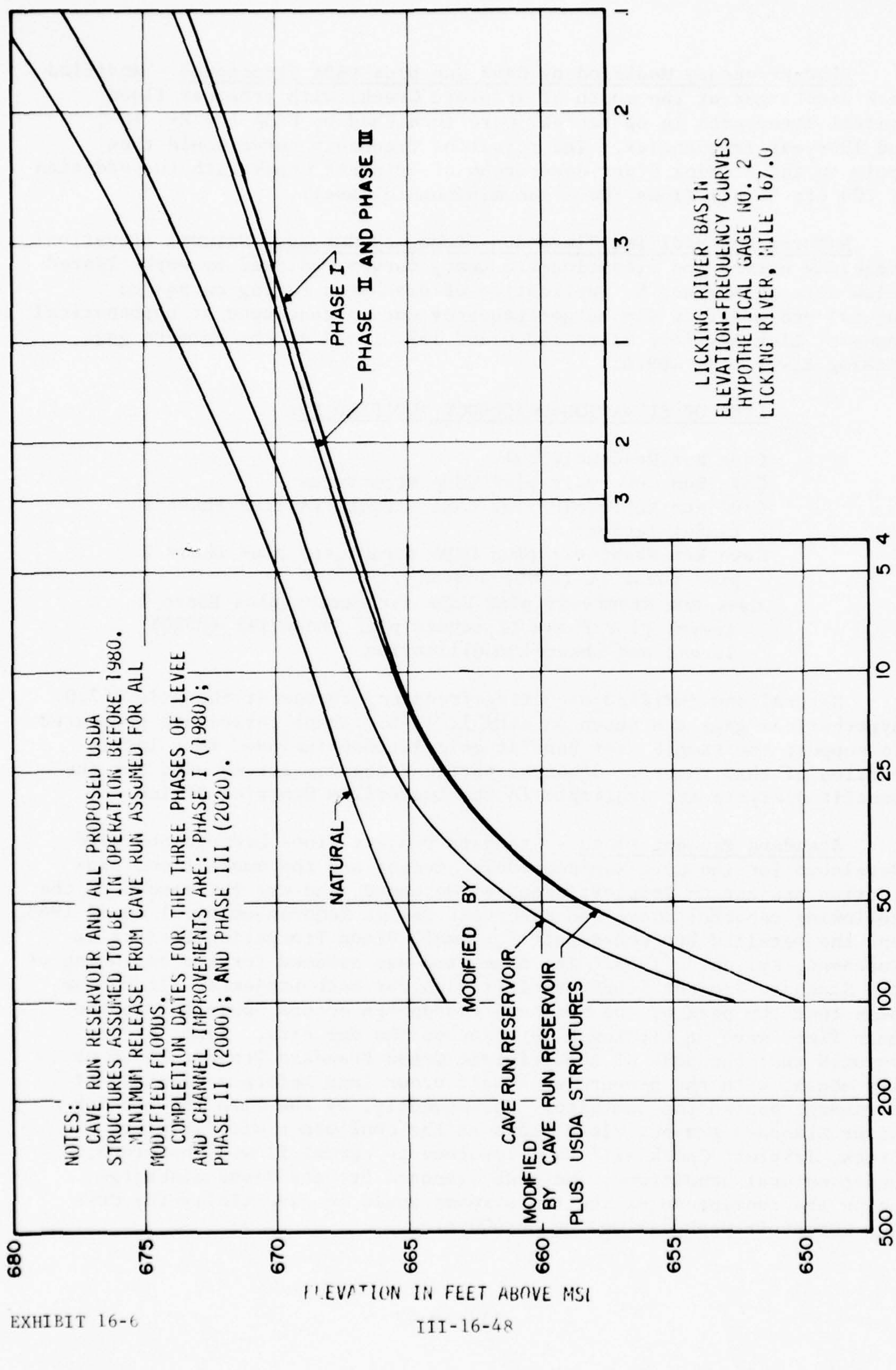
Natural and Modified Elevation-Frequency Curves - Natural elevation-frequency curves and elevation-frequency curves modified by works listed below were determined by application of discharge rating curves to natural and modified discharge-frequency curves developed at hypothetical gages at Licking River miles 163.0 and 167.0, and at the Farmers gage, Licking River mile 169.6.

LIST OF ELEVATION-FREQUENCY MODIFIED BY:

Cave Run Reservoir only
Cave Run Reservoir plus USDA structures
Cave Run Reservoir plus USDA structures plus Phase I (1980) levees
Cave Run Reservoir plus USDA structures plus Phase I plus Phase II (2000) levees
Cave Run Reservoir plus USDA structures plus Phase I levees plus Phase II levees plus Phase III (2020) levees and channel modification

Natural and modified elevation-frequency curves at the mile 167.0 hypothetical gage are shown on exhibit 16-6. These curves are presented to support the sample user benefit calculations included in a latter section of this report. Other elevation-frequency curves used for the benefit analysis are available in the Louisville District Office.

Standard Project Flood - Standard Project Flood hydrographs were developed for the Cave Run Reservoir Studies and the small flood protection project on Triplett Creek at Morehead, and are referenced in the following reports: Cave Run Reservoir Design Memorandum No. 1 dated 1963, and the Detailed Project Report for Small Flood Protection Project at Morehead, Ky. dated 1963. The same time was assumed for the beginning of the Standard Project Storm precipitation for both projects. It can be seen that the peak of the Morehead hydrograph occurs hours before the main flood wave on Licking River reaches the dam site. Also, it was assumed that the peak of the Triplett Creek Standard Project Flood at its mouth, with the 6-hour lag, would occur long before a significant discharge passed the dam site. Consequently, by the time the Licking River Standard Project Flood peaks at the confluence with Triplett Creek, Triplett Creek will have returned to normal flow. Therefore, under natural conditions, the peak Standard Project Flood discharge below the confluence of the two streams would be essentially the Cave Run Reservoir peak inflow, or 86,600 cfs.


LICKING RIVER BASIN
ELEVATION-FREQUENCY CURVES
HYPOTHETICAL GAGE NO. 2
LICKING RIVER, MILE 167.0
NOTES:
CAVE RUN RESERVOIR AND ALL PROPOSED USDA STRUCTURES ASSUMED TO BE IN OPERATION BEFORE 1980. MINIMUM RELEASE FROM CAVE RUN ASSUMED FOR ALL MODIFIED FLOODS.
COMPLETION DATES FOR THE THREE PHASES OF LEVEE AND CHANNEL IMPROVEMENTS ARE: PHASE I (1980); PHASE II (2000); AND PHASE III (2020).
PHASE I
PHASE II AND PHASE III
NATURAL
MODIFIED BY CAVE RUN RESERVOIR
MODIFIED BY CAVE RUN RESERVOIR PLUS USDA STRUCTURES
ELEVATION IN FEET ABOVE MSL
EXCEEDENCE FREQUENCY PER 100 YEARS
680
675
670
665
660
655
650
500
200
100
50
25
10
5
4
3
2
1
.3
.2
.1

With Cave Run Reservoir in operation, the SPF peak below the confluence would be 60,000 cfs plus the minimum release from flood control operations of 200 cfs from Cave Run, or 60,200 cfs. Cave Run Reservoir was assumed to have already utilized 50 percent of its flood control storage at beginning of the SPF. The value of 60,000 cfs for the Standard Project Flood at the mouth of Triplett Creek regulated by Cave Run Reservoir only, was obtained by extrapolating the relation between USDA peak hypothetical flood flows at Morehead and the mouth of Triplett Creek, as discussed in the paragraph on Natural Flow-frequency, Licking River below mouth of Triplett Creek. From the small flood protection project study at Morehead, Ky., the natural SPF peak discharge is 38,900 cfs. With this value at Morehead, the estimated peak discharge at the mouth of Triplett Creek was 60,000 cfs, based on the curve of Figure 16-11.

Considering USDA structures in place within the Triplett Creek basin, the modified Standard Project Flood Discharge at the mouth of Triplett Creek was estimated by extrapolating a curve of natural peaks vs. modified peaks on logarithmic paper, as shown on Figure 16-13. The extrapolated value for the modified SPF peak was 44,500 cfs. Including the minimum release of 200 cfs from the flood control operations of Cave Run Reservoir, the SPF peak flows modified by Cave Run Reservoir and the SCS structures on Triplett Creek was 44,700 cfs.

Water Surface Profiles - Water surface profiles on Licking River were computed using Manning's "n" values determined by reconstituting the observed May 1961 highwater profile on Licking River from mile 150.5 to the Cave Run damsite. The peak discharge below the mouth of Triplett Creek was obtained by the procedure described in the paragraph on Natural Flow-Frequency, Licking River below Mouth of Triplett Creek. This computed discharge, 16,400 cfs, exceeded the Farmers peak of 11,000 cfs. The average channel and overbank roughness coefficients determined were 0.040 and 0.070, respectively.

A discharge rating curve was constructed at mile 150.5 on Licking River by slope-area computations, utilizing Manning's formula, and was then extended to include the Standard Project Flood discharge. This curve provided the starting elevations for all hypothetical flood profiles considered in the study, for both natural and modified conditions.

The discharge rating curves, both natural and modified, developed at Licking River miles 163.0, 167.0, and at the Farmers gage, Licking River mile 169.6, were based on the computed backwater profiles. These discharge rating curves were then used to establish the natural and modified elevation-frequency curves described in the paragraph on Natural and Modified Elevation-Frequency Curves.

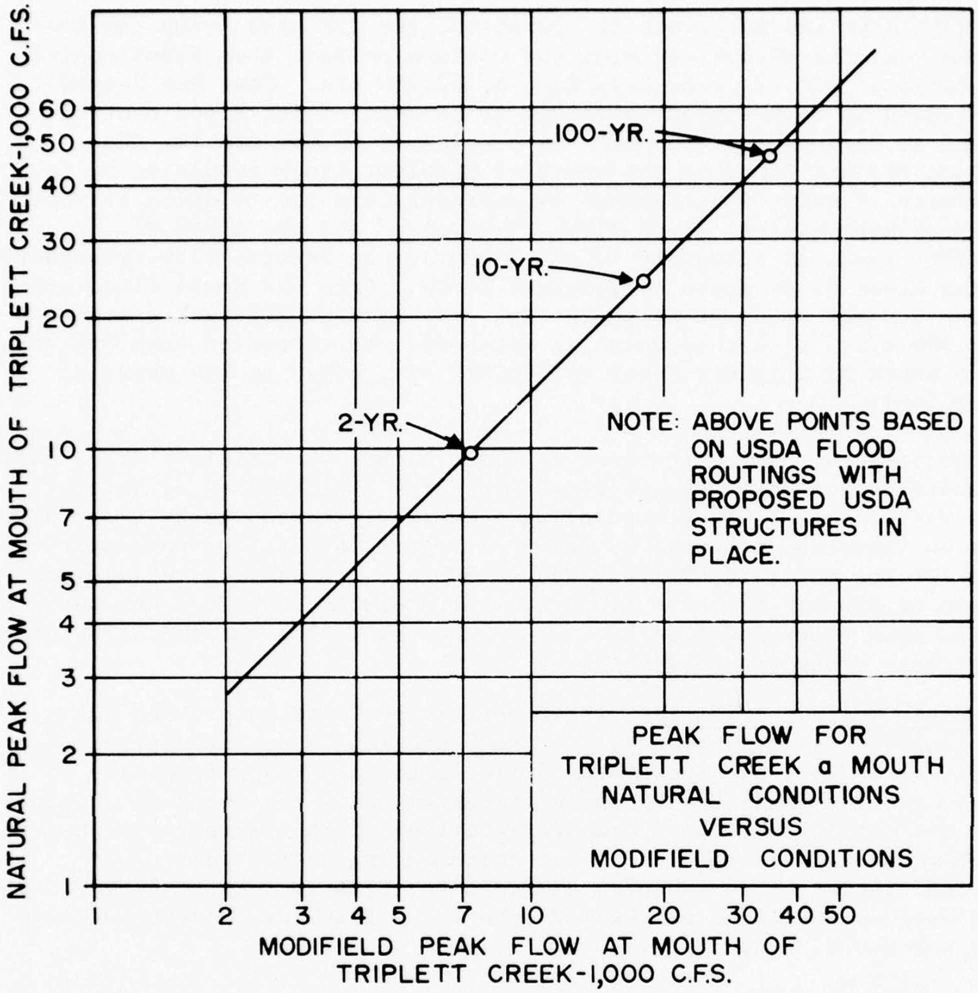

NATURAL PEAK FLOW AT MOUTH OF TRIPLETT CREEK-1,000 C.F.S.
60
50
40
30
20
10
7
5
4
3
2
1
100-YR.
10-YR.
2-YR.
NOTE: ABOVE POINTS BASED ON USDA FLOOD ROUTINGS WITH PROPOSED USDA STRUCTURES IN PLACE.
PEAK FLOW FOR TRIPLETT CREEK a MOUTH NATURAL CONDITIONS VERSUS MODIFIELD CONDITIONS
1
2
3
4
5
7
10
20
30
40
50
MODIFIELD PEAK FLOW AT MOUTH OF TRIPLETT CREEK-1,000 C.F.S.

FIGURE 16-13

Shown on exhibit 16-5 is the design profile (Standard Project Flood), the proposed levee grade profile, and the 100-year frequency profile. The three profiles are for the modified condition with Cave Run Reservoir and the USDA structures in place, plus all three phases of levees and channel modification. The levee grade was set equal to the design profile plus three feet of freeboard.

Interior Drainage - Plans were developed for disposition of the interior runoff in the protected areas by ponding areas and gravity drainage structures; pumping plants; and a combination thereof. The least costly system was found to be one which utilizes gravity drainage structures with available ponding areas supplemented by pumping plants at locations where ponding would not be available or where the planned development structure and installations would be susceptible to substantial damage from excessive ponding. Topography is expected to be drastically altered during construction within the protected areas and drainage design will be subject to modification to conform to changes in the drainage pattern, where appropriate, during subsequent design studies.

Studies were made to determine the size requirements of the drainage structures to provide 100-year protection against damage in the protected area, in accordance with the criteria in EM 1110-2-1410, "Interior Drainage of Leveed Urban Areas, Hydrology", dated May 1965, as specified for Class I areas. Structural size requirements for two typical areas were determined by routing computed runoff hydrographs from the 100-year design storm through available storage and also by assuming no storage. These results were related to generalized curves of gravity structure size versus drainage area for various types of topography prepared by this office for preliminary studies. It was found that the gravity structure size utilizing ponding corresponded to a type of topography requiring smaller culverts than when storage was not considered. This finding was used to estimate the difference in culvert size for the other areas with and without available storage. Preliminary gravity structure requirements are given in table 16-13.

TABLE 16-13

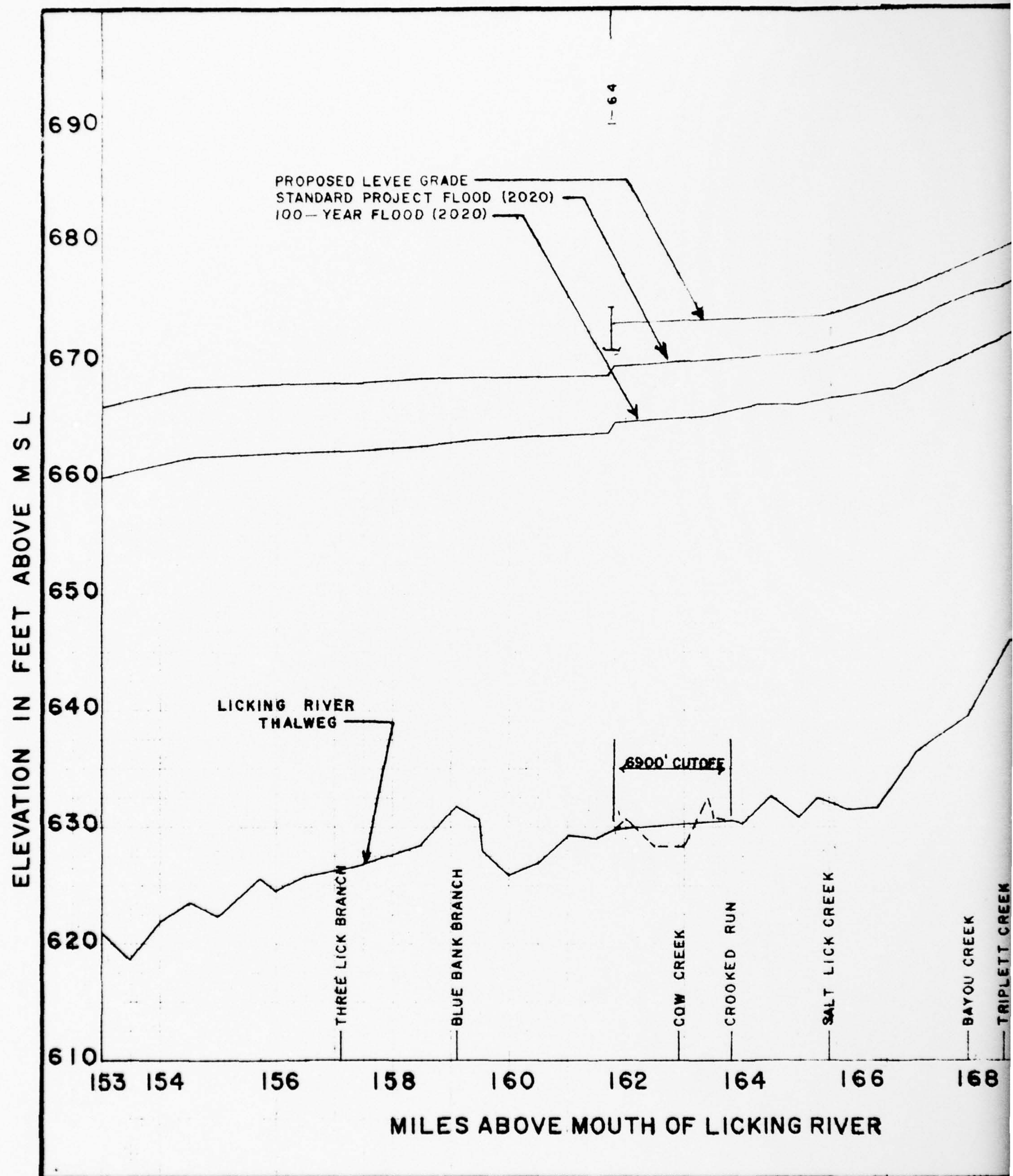
GRAVITY OUTLET STRUCTURES REQUIRED

Water-shed	Drainage Area (acres)	Design Highwater (100-year freq.)	Culvert Size With Ponding	Culvert Size Without Ponding
A	100	665	-	54" x 150' CMP
B-1	812	670	2-72" x 70' CMP */	10' x 8' x 70' CBC
B-2	733	660	-	1-10' x 8' x 80' CBC
C	890	656	2-72" x 130' CMP	2-7' x 7' x 130' CBC
D	2,505	655	13' x 10' x 120' CBC **/	2-11' x 10' x 120' CBC
E	143	667	42" x 120' CMP	60" x 120' CMP
F	204	660	-	72" x 130' CMP
G	352	670	1-72" x 110' CMP	2-66" x 110' CMP

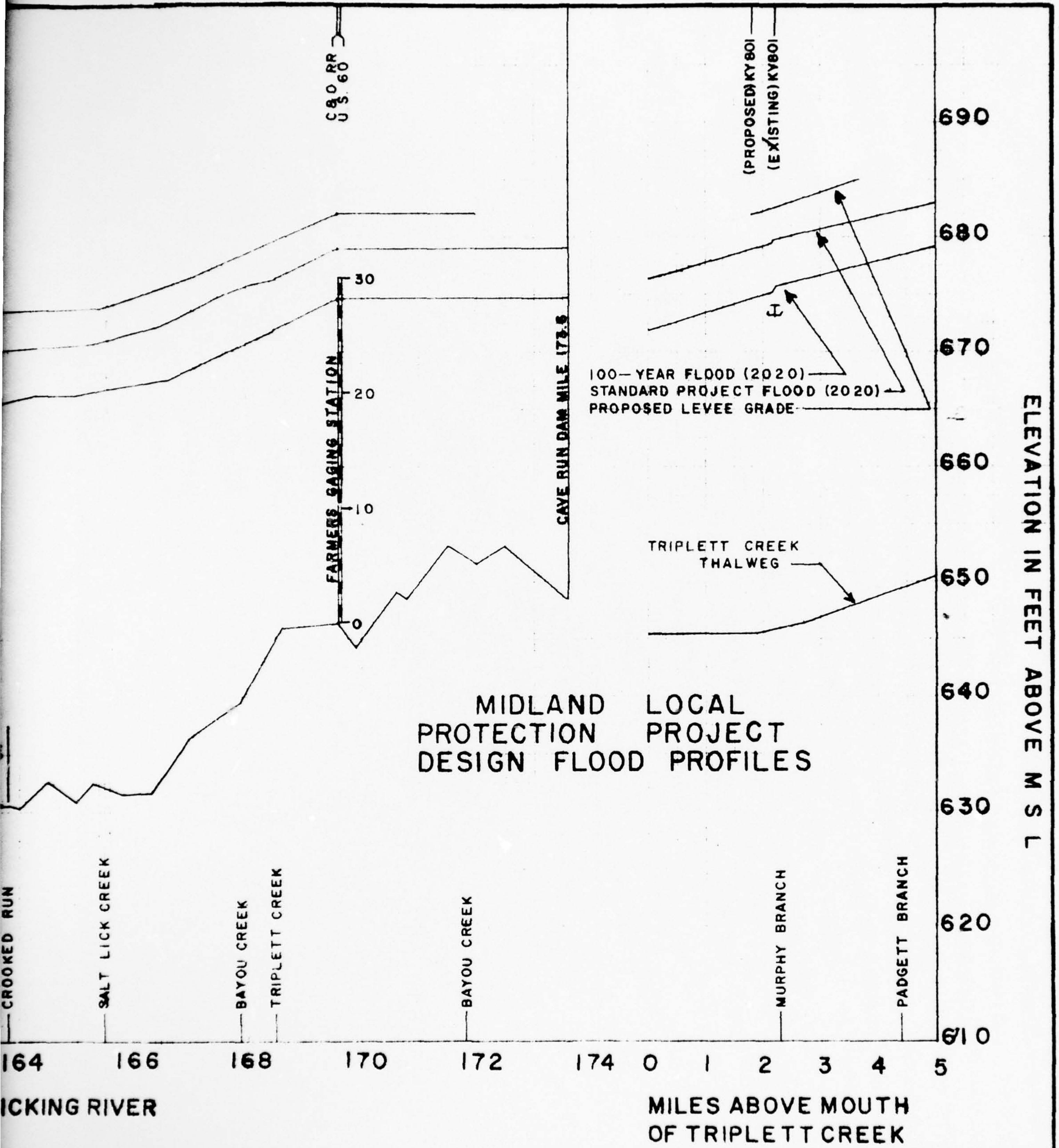
*/ Corrugated Metal Pipe
**/ Concrete Box Culvert

Since the Midland area will be protected against Licking River floods up to the magnitude of the standard project flood by Cave Run Reservoir, the interior runoff discharge through the gravity drainage structures will be impeded only at times when major floods of Triplett and Salt Lick Creeks cause high levels in the Licking River. Inasmuch as the outfall inverts would be about the bankfull stage, interruption of gravity drainage will be very infrequent. Also, the duration above this stage will be relatively short, due to the rapid recession of the flood hydrographs of the creeks. In accordance with the requirements of EM 1110-2-1410, and based on coincident frequency relations outlined therein, the adopted design rainfall used for all pumping stations was approximately the same as all-season one-year rainfall as published in Technical Paper No. 40, the Weather Bureau of the U. S. Department of Commerce, dated May 1961.

The rational method (Q=CIA) was used to determine the peak rate of runoff to each station. The assumed runoff coefficient "C" for the larger areas varied from 0.5 to 0.6 and was selected to make the results of the rational formula correspond to results determined by the unit hydrograph method for two typical areas. For areas less than 500 acres the assumed runoff coefficient varies with proposed land use from 0.6 for low density residential areas to 0.8 for business and industry.


I-64
PROPOSED LEVEE GRADE
STANDARD PROJECT FLOOD (2020)
100-YEAR FLOOD (2020)
LICKING RIVER THALWEG
6900' CUTOFF
THREE LICK BRANCH
BLUE BANK BRANCH
COW CREEK
CROOKED RUN
SALT LICK CREEK
BAYOU CREEK
TRIPLETT CREEK
ELEVATION IN FEET ABOVE MSL
610
620
630
640
650
660
670
680
690
153
154
156
158
160
162
164
166
168
MILES ABOVE MOUTH OF LICKING RIVER

2


C&O RR
US 60
(PROPOSED) KY 801
(EXISTING) KY 801
FARMERS GAGING STATION
CAVE RUN DAM MILE 173.6
30
20
10
0
100—YEAR FLOOD (2020)
STANDARD PROJECT FLOOD (2020)
PROPOSED LEVEE GRADE
TRIPLETT CREEK
THALWEG
MIDLAND LOCAL
PROTECTION PROJECT
DESIGN FLOOD PROFILES
690
680
670
660
650
640
630
620
610
ELEVATION IN FEET ABOVE M S L
CROOKED RUN
SALT LICK CREEK
BAYOU CREEK
TRIPLETT CREEK
BAYOU CREEK
MURPHY BRANCH
PADGETT BRANCH
164
166
168
170
172
174
0
1
2
3
4
5
ICKING RIVER
MILES ABOVE MOUTH
OF TRIPLETT CREEK

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To show the benefit of available ponding, a separate study of Midland pumping requirements was made with natural ponding reserved. These requirements were based on a generalized study of all existing pumping plants with available storage in the Louisville District. The results of the studies of Midland pumping plants with and without storage are shown on table 16-14.

TABLE 16-14

ESTIMATE OF PUMPING REQUIREMENTS

Phase	Watershed	Drainage Area in (acres)	Peak Design Inflow (cfs)	Design Ponding Storage (in.)	Required Pumping Capacity (cfs) without ponding	with ponding
I	A	100	210	0	210	0
	B-1	812	660	1.9	609	220
	E	143	322	7.0	300	0
	G	352	357	0.8	328	120
II	B-2	733	823	0	748	0
	D	2,505	1,880	0.4	1,730	540
	F	204	--	0	343	0
III	C	890	870	0.3	800	250

The interior drainage areas and the locations of all gravity drainage structures and pumping stations are shown on exhibit 16-1 .

10. GEOLOGIC

Introduction - The purpose of geologic investigations made at Midland was; (1) to provide general information on the area's geology; (2) to determine the suitability of foundation conditions beneath levee sections and pump installations being considered; and (3) to determine whether material suitable for levee construction is available within the immediate vicinity of the considered levees.

General Geologic Information - The project area is located along the border of the Outer Bluegrass and Eastern Coal Fields regions of Kentucky. The Licking River flood plain, developed on the Devonian Ohio Black shale, is about one mile wide at the upstream end of the project. At the junction with Triplett Creek, the flood plain widens to about 1-1/2 miles. The river turns northward at the Salt Lick Creek junction where the valley widens slightly to the lower end of the project and is developed on the Silurian Crab Orchard shale. At the project site the hills are capped by Mississippian sandstones, siltstones and shales on the upstream end. The hills at the downstream end are capped by Mississippian and Devonian black shale until it flows northward from Salt Lick where it is developed on Silurian grey-green shale. Topography is characterized by dendritic drainage developed on steep hillside slopes. Relief ranges from 500 to 600 feet. The flood plains are relatively flat with some terraces. The meandering Licking River has left several oxbox lakes.

Investigations Made - Since no previous investigations within the immediate vicinity of Midland had been made by this office and since borings for Cave Run Dam are too far away to be of use it was necessary to drill seventeen 6" power auger holes in the vicinity of considered works. Jar soil samples were taken and were tested for moisture content and visually identified. Locations of borings are shown on exhibit 16-1.

Foundation Conditions - No unusual foundation conditions were encountered during drilling. Overburden coverage is fairly constant over most of the area. Bedrock was encountered at from 20 to 30 feet deep at elevation 635-650±. Shale outcrops in the Licking River bed at mile 155 and mile 161.5. The Crab Orchard shale shows several feet of weathering while the Ohio Black shale is relatively unweathered on its surface. Bedding is essentially horizontal with a regional dip of about 35 to 40 feet per mile to the southeast. No faults are known to be in the immediate area. The Ohio Black shale and the Sunbury shale are well jointed and there is sufficient cover in most areas that seepage problems are not anticipated. The fine sand would have a low rate of permeability.

Exhibit 16-7 depicts the geologic column in the immediate area of Midland. The boring logs are shown on exhibit 16-8.

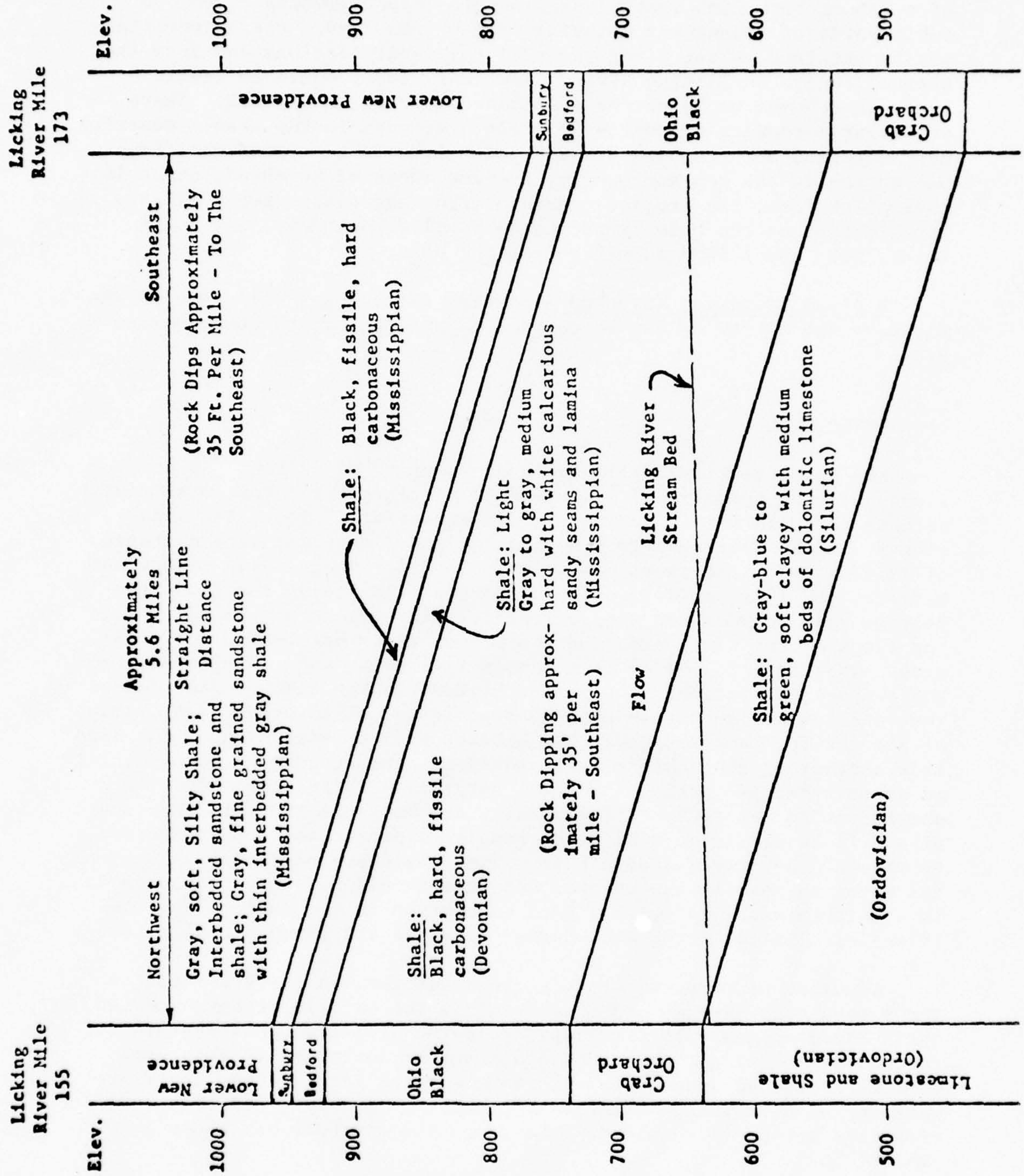


Exhibit 16-7. Geologic Column of the Midland Area.

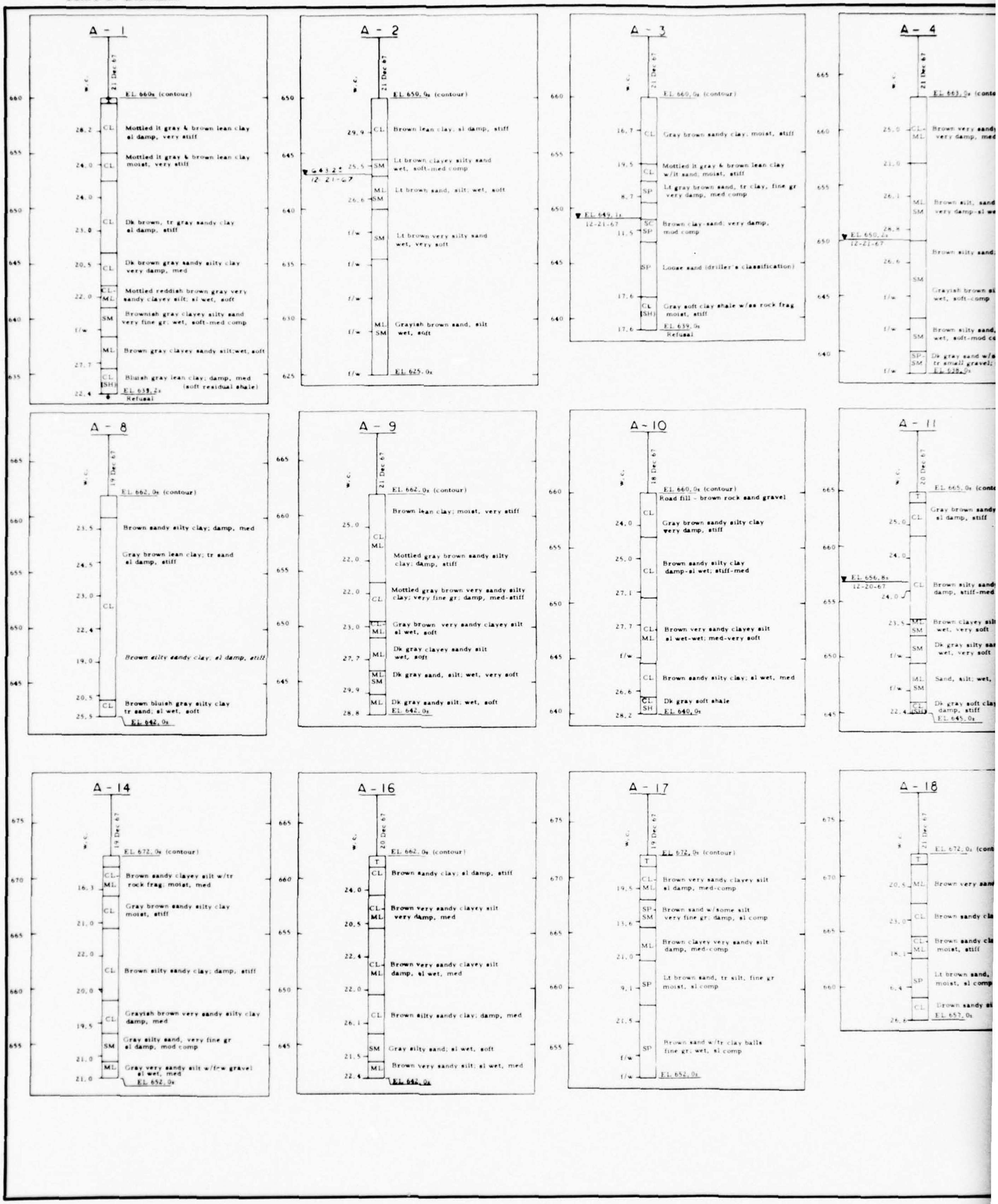
Construction Materials - Levee embankment will be constructed of a random core with impervious blanket. Approximately 2,300,000 cubic yards of embankment material will be required. Borrow material may be obtained on the river sides of the levee sections and from the channel change on Licking River. Rock cut slopes would be stable but rock removed would not be suitable for levee embankment. There are several sources of coarse concrete aggregate in the area. Quarries near Morehead are crushing Mississippian limestone of good quality. One source is the Ken-Mor Quarry, 5 miles south of Morehead, about 16 road miles from the project. Natural fine aggregates are available from sources on the Ohio River near Maysville, Kentucky, and South Point, Ohio, about 50 road miles from the site.

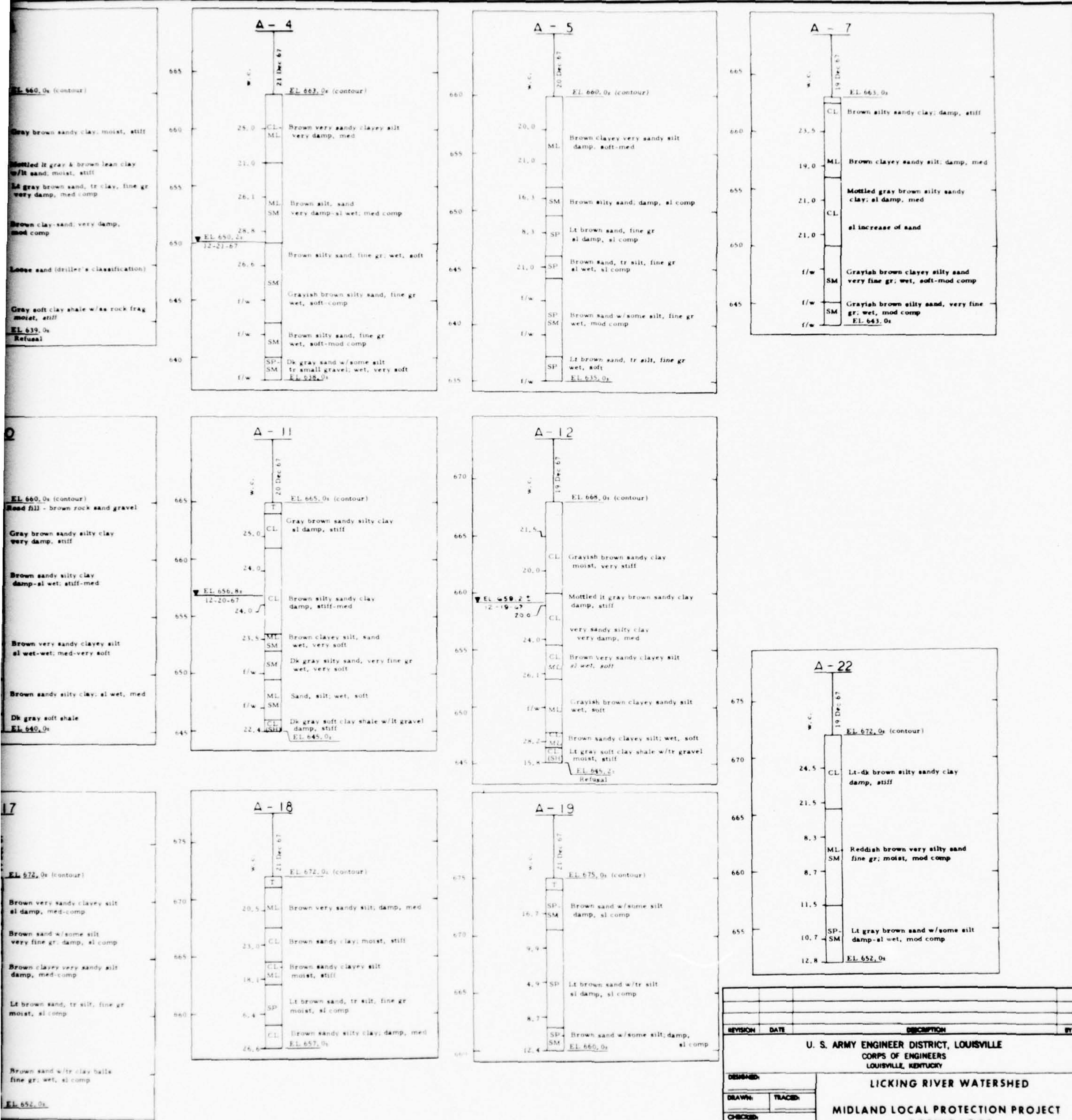
Mineral Resources Affected - Several oil and gas wells are in the vicinity but as far as can be determined are out of the construction area.

11. STRUCTURAL

The levee sections will have a crown width of 12 feet. Side slopes will be symmetrical 3 horizontal and 1 vertical for embankment heights up to 15 feet. For heights in excess of 15 feet, the side slopes will be flattened to 4 horizontal and 1 vertical at a distance of 12 feet below the crown elevation. In order to conserve impervious material and thus avoid location of borrow pits inside the levee the section will be modified with a four-foot impervious blanket normal to the slope of the river side and a one-foot thick blanket on the land side. The levee core will be a random fill using sand and gravel from the channel excavation. A one-foot filter blanket will be provided at the landside toe on levees over 10 feet in height to prevent saturation of the toe from any seepage. The blanket will be placed under the land-side quarter of the embankment foundation. The levee will be constructed as an urban protection, that is, material will be compacted with sheepsfoot roller to specified density and moisture content. No open pits will be permitted behind the completed protection. Borrow areas outside of the levees should have a limiting depth not lower than normal water surface in the channel and they should be excavated landward in a uniform slope to drain. Rock excavation in the channel would be in shale. Typical levee and channel sections are shown on exhibit 16-9.

A number of ramp and closure crossings through levee sections 5 and 6 were necessary in order to maintain the existing transportation net. Flood stages rise very rapidly in the Triplett Creek Basin; therefore, normal gate closures could not be installed in this area, as there would be inadequate time to erect the gates. Ramp crossings were included in the plan wherever possible. However, five rapid-closure crossings are still required. The ramps and closures are shown on exhibit 16-1.


A - 1
21 Dec 67
EL 660± (contour)
Mottled lt gray & brown lean clay sl damp, very stiff
Mottled lt gray & brown lean clay moist, very stiff
Dk brown, tr gray sandy clay sl damp, stiff
Dk brown gray sandy silty clay very damp, med
Mottled reddish brown gray very sandy clayey silt; sl wet, soft
Brownish gray clayey silty sand very fine gr; wet, soft-med comp
Brown gray clayey sandy silt; wet, soft
Bluish gray lean clay; damp, med (soft residual shale)
EL 638.2±
Refusal
A - 2
21 Dec 67
EL 650.0± (contour)
Brown lean clay; sl damp, stiff
Lt brown clayey silty sand wet, soft-med comp
643.2±
12-21-67
Lt brown sand, silt; wet, soft
Lt brown very silty sand wet, very soft
Grayish brown sand, silt wet, soft
EL 625.0±
A - 3
21 Dec 67
EL 660.0± (contour)
Gray brown sandy clay; moist, stiff
Mottled lt gray & brown lean clay w/lt sand; moist, stiff
Lt gray brown sand, tr clay, fine gr very damp, med comp
EL 649.1±
12-21-67
Brown clay-sand; very damp, med comp
Loose sand (driller's classification)
Gray soft clay shale w/ss rock frag moist, stiff
EL 639.0±
Refusal
A - 4
A - 8
19 Dec 67
EL 662.0± (contour)
Brown sandy silty clay; damp, med
Gray brown lean clay; tr sand sl damp, stiff
Brown silty sandy clay; sl damp, stiff
Brown bluish gray silty clay tr sand; sl wet, soft
EL 642.0±
A - 9
21 Dec 67
EL 662.0± (contour)
Brown lean clay; moist, very stiff
Mottled gray brown sandy silty clay; damp, stiff
Mottled gray brown very sandy silty clay; very fine gr; damp, med-stiff
Gray brown very sandy clayey silt sl wet, soft
Dk gray clayey sandy silt wet, soft
Dk gray sand, silt; wet, very soft
Dk gray sandy silt; wet, soft
EL 642.0±
A - 10
18 Dec 67
EL 660.0± (contour)
Road fill - brown rock sand gravel
Gray brown sandy silty clay very damp, stiff
Brown sandy silty clay damp-sl wet; stiff-med
Brown very sandy clayey silt sl wet-wet; med-very soft
Brown sandy silty clay; sl wet, med
Dk gray soft shale
EL 640.0±
A - 11
A - 14
19 Dec 67
EL 672.0± (contour)
Brown sandy clayey silt w/tr rock frag; moist, med
Gray brown sandy silty clay moist, stiff
Brown silty sandy clay; damp, stiff
Grayish brown very sandy silty clay damp, med
Gray silty sand, very fine gr sl damp, mod comp
Gray very sandy silt w/few gravel sl wet, med
EL 652.0±
A - 16
20 Dec 67
EL 662.0± (contour)
Brown sandy clay; sl damp, stiff
Brown very sandy clayey silt very damp, med
Brown very sandy clayey silt damp, sl wet, med
Brown silty sandy clay; damp, med
Gray silty sand; sl wet, soft
Brown very sandy silt; sl wet, med
EL 642.0±
A - 17
19 Dec 67
EL 672.0± (contour)
Brown very sandy clayey silt sl damp, med-comp
Brown sand w/some silt very fine gr; damp, sl comp
Brown clayey very sandy silt damp, med-comp
Lt brown sand, tr silt, fine gr moist, sl comp
Brown sand w/tr clay balls fine gr; wet, sl comp
EL 652.0±
A - 18



REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

DESIGNED:
DRAWN: TRACED:
CHECKED:
SUBMITTED:
APPROVAL RECM:
APPROVED:

LICKING RIVER WATERSHED

MIDLAND LOCAL PROTECTION PROJECT
BORING LOGS

SCALE: AS SHOWN
DRAWING NUMBER

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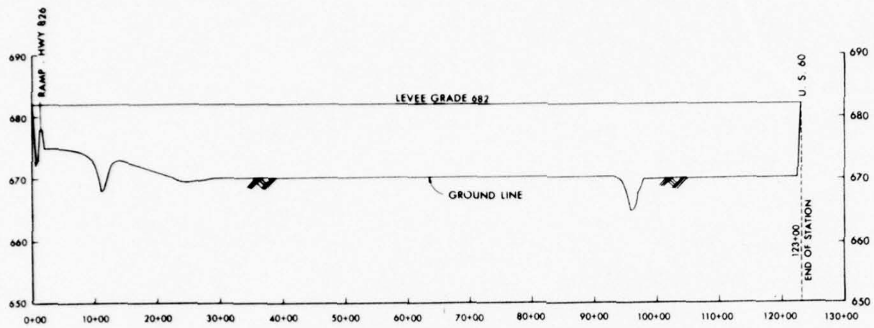
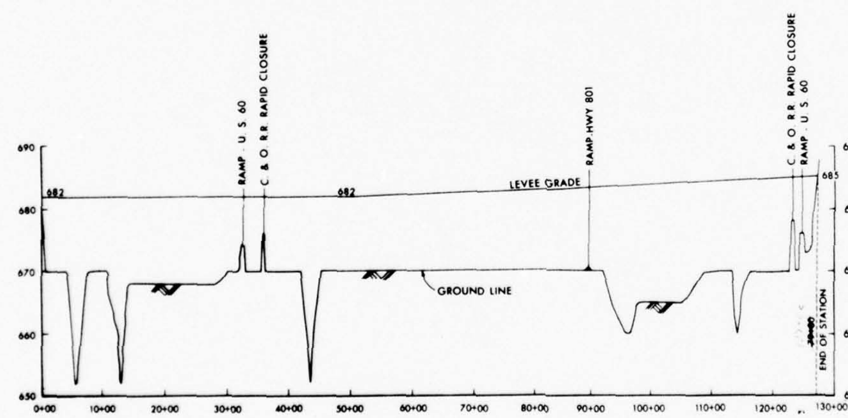
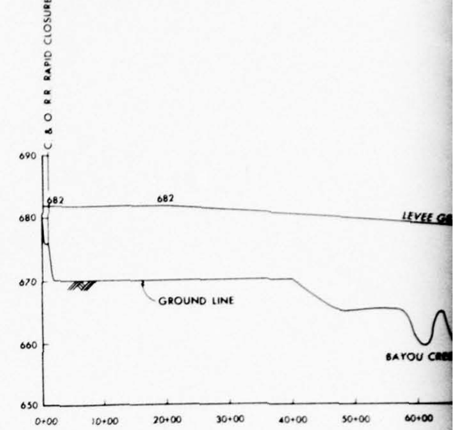


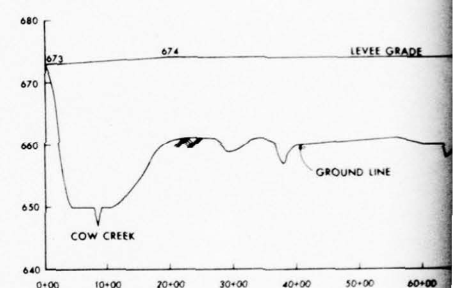
PHASE 1 - LEVEE SECTION 1 - PROFILE



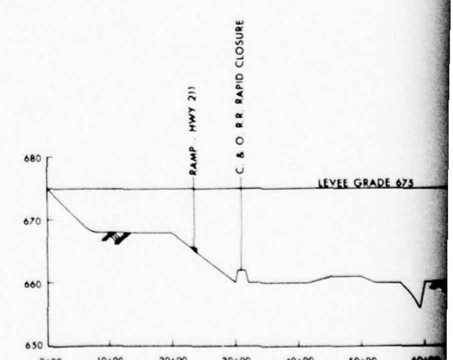
PHASE 1 - LEVEE SECTION 5 - PROFILE



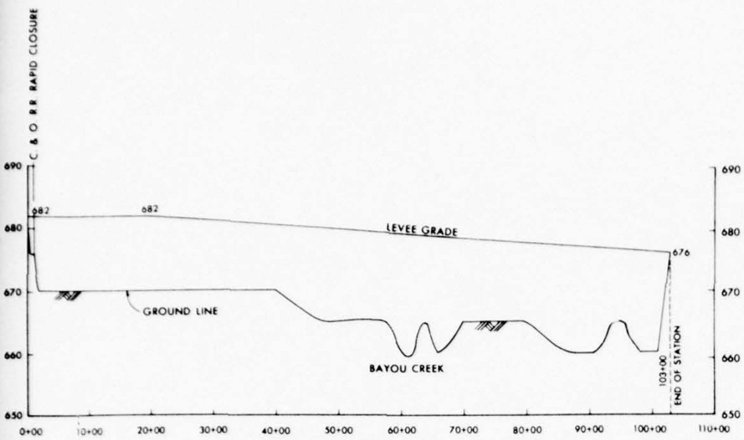
PHASE 2 - LEVEE SECTION 2



PHASE 2 - LEVEE SECTION 4 - PROFILE



PHASE 2 - LEVEE SECTION 6 -



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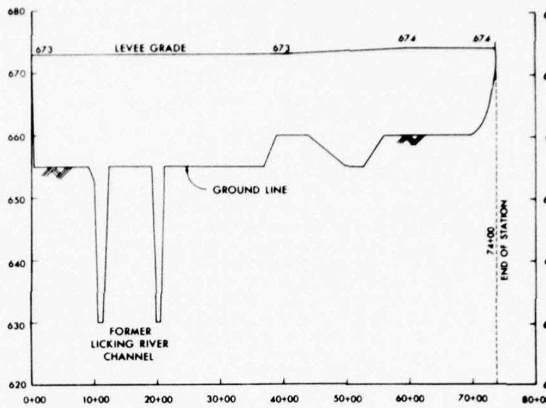

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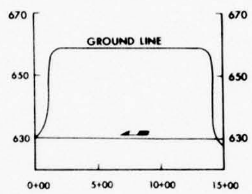
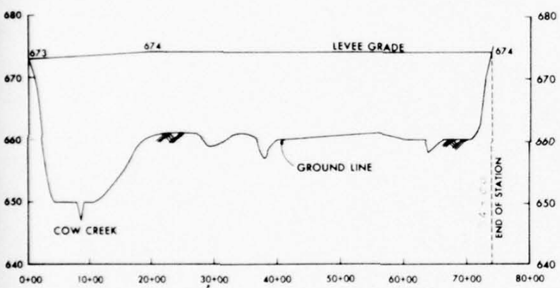


LICKING RIVER CUT-OFF, PHASE 3



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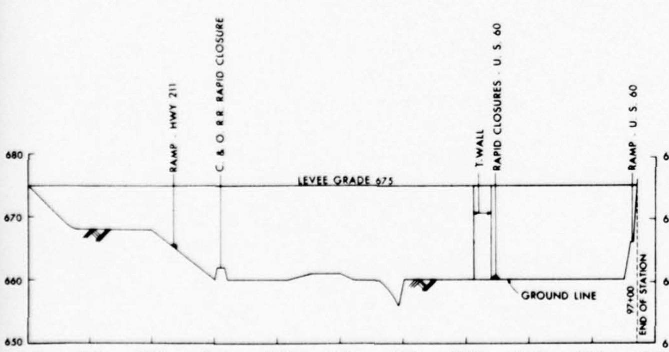
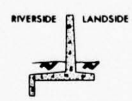
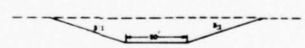


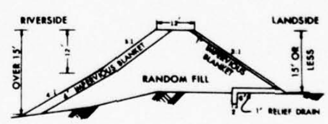
PHASE 2 - LEVEE SECTION 6 - PROFILE



TYPICAL T-WALL
SCALE 1" = 20'



TYPICAL CHANNEL SECTION



TYPICAL LEVEE SECTION

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

MIDLAND LOCAL PROTECTION PROJECT
LEVEE, WALL AND CHANNEL SEGMENTS
PROFILES AND SECTIONS

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT — LOUISVILLE, KENTUCKY

ORLED-P — OCTOBER 1968

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Due to space limitations a section of concrete T-wall has been included in Levee Unit No. 6. This wall section is located in Section six in exhibit 16-1, and a cross-section is shown on exhibit 16-9.

Pumping plants would be located to take advantage of ponding areas wherever possible. Old sloughs and stream channels can be used for ponding purposes. Except for Levee Section 5, each section of levee requires only one pumping plant. The interior drainage system for Levee Section 5 is split into three portions by roads, railroad, and natural barriers. Because of availability of ponding areas at two sites and the expense of constructing diversion ditches three separate gravity outlets and two pumping plants are required.

Locations of pumping plants and gravity outlet structures are shown on exhibit 16-1 and pertinent data are shown in tables 16-14 and 16-13.

12. RELOCATIONS AND ALTERATIONS

Raising approximately 4200 feet of U.S. Highway 60 during Phase I construction would be necessary since Levee Section 2 will not be constructed until Phase II (2000). This modification is shown on exhibit 16-1. No railroad alterations or relocations will be required. The Tennessee Gas Pipeline Company and the Columbia Gulf Transportation Company both have gas lines crossing the study area. Tennessee Gas Pipeline Company lines intersect the levees a total of 9 times, and must be altered at these intersections. Public and private utilities will be relocated or altered as required. The cost of raising U.S. Highway 60 will be shared by Federal and non-Federal interests, as the highway fill will be used as part of the water protection plan. All other relocation and alteration costs will be the responsibility of non-Federal interests.

13. REAL ESTATE REQUIREMENTS

Installation of the water project recommended herein (element one of the selected plan) would require fee title acquisition of 195 acres of land for right-of-way purposes. In addition, approximately 150 acres will be needed for ponding easements. Ponding areas can be utilized for non-flood damageable use if total ponding storage is not significantly infringed upon. In order to preserve the structural integrity of the levees an easement must be taken on subsurface rights of about 520 acres of land. About 120 acres will be required for borrow areas. It cannot be determined at this time whether fee acquisition of these borrow areas will be necessary. It has been assumed that necessary borrow materials can be obtained by taking of borrow area easements. All fee title lands and easements must be

acquired by non-Federal interests. A breakdown of real estate requirements by phase is furnished in table 16-15.

TABLE 16-15

REAL ESTATE REQUIREMENTS (ELEMENT 1)

Phase	Rights-of-Way (fee title) (acres)	Easements Ponding (acres)	Easements Borrow (acres)	Easements Subsurface (acres)
I	72	70	38	220
II	89	50	71	240
III	34	30	11	60
Totals	195	150	120	520*/

*/ Includes 195 acres of rights-of-way lands.

In some cases partial taking of portions of specific land units would adversely affect the residual portion of the land and buildings. An amount is included in the cost estimate for the estimated damages which would result from severance. A cost is also included for damages to buildings and improvements.

14. RECREATION

Recreation has not been included as a project purpose in the selected local flood protection plan. Neither beneficial nor detrimental effects of the plan on the area's fish and wildlife resources are expected to be of much consequence. Therefore, no fish and wildlife mitigating measures are proposed and no enhancement benefits to fish and wildlife resources have been evaluated. The U.S. Fish and Wildlife Service has stated that this plan would not significantly effect the area's fish and wildlife resources.

SECTION IV - COST ESTIMATES

15. PROJECT COSTS

A summary of estimated first costs and annual economic charges for both elements of the selected plan is shown in table 16-16. The table also shows apportionment of costs between Federal and non-Federal interests. Detailed estimates and explanations of first costs and annual charges are presented in subsequent paragraphs of this Section.

TABLE 16-16

SUMMARY OF ESTIMATED FIRST COSTS, AND ANNUAL ECONOMIC CHARGES FOR THE SELECTED PLAN

Items	Federal	Non-Federal	Total
		FIRST COSTS 1/	
Water Resource Plan			
Phase I (1980)	$ 2,364,000	$ 276,000	$ 2,640,000
Phase II (2000)	3,834,000	306,000	4,140,000
Phase III (2020)	1,366,000	84,000	1,450,000
Subtotals	$ 7,564,000	$ 666,000	$ 8,230,000
Development Plan			
Net Investment Cost	$24,500,000	$363,500,000	$388,000,000
TOTALS	$32,064,000	$364,166,000	$396,230,000
		ANNUAL CHARGES 2/	
Water Resource Plan			
Phase I (1980)	$ 58,100	$ 31,900	$ 90,000
Phase II (2000)	49,700	18,300	68,000
Phase III (2020)	9,500	2,500	12,000
Subtotals	$ 117,300	$ 52,700	$ 170,000
Development Plan			
Net Investment Cost	$ 400,000	$ 9,220,000	$ 9,620,000
TOTALS	$ 517,300	$ 9,272,700	$ 9,790,000

1/ July 1968 Prices
2/ Average Annual Equivalent Charges During 100-year period of analysis.

Local Protection Project - The total construction cost of all three phases is estimated to be $8,230,000. This cost includes contingencies, engineering and design, supervision and inspection, and overhead. Contingency amounts are based on the degree of adequacy of information of which the estimates are based and approximates 20 percent of the estimated cost of the item. Engineering and design, supervision and inspection, and overhead charges have been taken from curves based on Government costs for past civil works projects. A summary of first cost by construction phase is given in table 16-17. Summary cost estimates by phases and detailed cost estimated by levee sections are presented in tables 16-19, -23, -28, and 16-21, -22, -25, -26, -27, and -30, respectively.

Average annual financial charges were developed for the three phases. A summary of annual charges by phase is presented in table 16-18. Because the construction periods are less than two years, no interest is charged during construction and the construction costs equal the investment costs. The current Federal interest rate of 3.25 percent was used for discounting all Federal and non-Federal construction costs to 1970 and for amortizing the present worths of these amounts over the 100-vear period from 1970 to 2070.

A 100-year period of analysis would normally be used for economic evaluation of the levee and wall sections included in the selected plan. However, in this case these works would be installed in phases (1980, 2000 and 2020) and project lives of all three phases would never end at a common point in time. It is necessary that average annual costs of these works be comparable with benefits to be derived therefrom. These benefits depend in a large part upon economic developments which are based upon projections of population and employment that cannot be projected with any accuracy beyond 100 years. For these reasons the period of analysis selected for the evaluation is the 100-year period from 1970 to 2070. Thus the periods of analysis used for evaluating flood protective works planned for 1980, 2000 and 2020 are respectively 90, 70, and 50 years. Estimates of annual charges utilizing these economic lives are given in tables 16-20, -24, and -29. Average annual discounted charges shown in table 16-18 are the average annual equivalents during the 100-year period of analyses and should be used for the indices of performance comparisons. These annual charges were derived as follows:

(1) The average annual charges were derived for the different levee phases over their separate project lives:

(2) The present worths of these annual charges were then determined for each phase for the year when that phase is to be completed (1980, 2000 and 2020);

(3) These present worths were then discounted back to their 1970 present worth;

(4) The 1970 present worths were then amortized over the 100-year period of analysis (1970-2070). This analysis yields the average annual equivalents necessary for comparison.

TABLE 16-17

SUMMARY OF FIRST COSTS MIDLAND LOCAL PROTECTION PROJECT
(July 1968 Prices)

Item	Cost Phase I*/	Phase II*/	Phase III*/
FEDERAL			
Levees and Channels	$ 879,000	$1,234,000	$ 500,000
Interior Drainage	739,000	1,398,000	435,000
Contingencies	324,000	524,000	187,000
Engineering and Design	245,000	395,000	140,000
Supervision and Inspection	109,000	172,000	64,000
Overhead	68,000	111,000	40,000
Total Federal First Cost	$2,364,000	$3,834,000	$1,366,000
NON-FEDERAL			
Lands and Damages	$ 133,000	$ 191,000	$ 36,000
Relocations	85,000	55,000	29,000
Contingencies	43,000	46,000	13,000
Supervision and Administration	15,000	14,000	6,000
Total Non-Federal First Cost	$ 276,000	$ 306,000	$ 84,000
Total First Cost	$2,640,000	$4,140,000	$1,450,000
TOTAL FIRST COST ALL PHASES -	$8,230,000		

*/ Phase I to be completed in 1980.
Phase II to be completed in 2000.
Phase III to be completed in 2020.

TABLE 16-18

SUMMARY OF ANNUAL CHARGES MIDLAND
LOCAL PROTECTION PROJECT

Item	Phase I 1980	Phase II 2000	Phase III 2020
FEDERAL			
Interest @ 3-1/4%	$ 76,800	$124,600	$44,400
Amortization 1/	4,600	14,900	11,200
Total Annual Federal Charges	$ 81,400	$139,500	$55,600
NON-FEDERAL			
Interest	$ 9,000	$ 9,900	$ 2,700
Amortization 1/	500	1,200	700
Loss in Land Productivity	400	500	200
Operation and Maintenance	30,000	36,000	10,000
Major Replacements	4,700	4,000	1,000
Total Annual Non-Federal Charges	$ 44,600	$ 51,600	$14,600
Total Annual Charges	$126,000	$191,100	$70,200
Rounded and discounted 2/	90,000	68,000	12,000

Total Annual Charges All Phases - Discounted - $170,000

1/ Phase I - 90-year life, amortization factor = .00194.
Phase II - 70-year life, amortization factor = .00388.
Phase III - 50-year life, amortization factor = .00823.

2/ (29.03937) (.72627) (.03388) = .71454 Phase I
(27.48969) (.38309) (.03388) = .35679 Phase II
(24.55176) (.20207) (.03388) = .16808 Phase III

TABLE 16-31

TABLE 16-19

SUMMARY OF FIRST COSTS, PHASE I
(July 1968 Prices)

Item	Cost Section 1	Cost Section 5
FEDERAL		
Levees */	$ 389,000	$ 490,000
Interior Drainage	269,000	470,000
Contingencies	132,000	192,000
Engineering and Design	100,000	145,000
Supervision and Inspection	44,000	65,000
Overhead	28,000	40,000
Total Federal First Cost	$ 962,000	$1,402,000
NON-FEDERAL		
Lands and Damages	$ 52,000	$ 81,000
Relocations	58,000	27,000
Contingencies	22,000	21,000
Supervision and Administration	8,000	7,000
Total Non-Federal First Cost	$ 140,000	$ 136,000
Total First Cost	$1,102,000	$1,538,000

TOTAL FIRST COST, PHASE I - $2,640,000

*/ Includes raising 4,200' of U.S. Highway 60 in Section 1

TABLE 16-20

ESTIMATE OF ANNUAL CHARGES, PHASE I
(July 1968 Prices)

Item	Cost Section 1	Cost Section 5
FEDERAL		
Interest @ 3-1/4%	$ 31,200	$45,600
Amortization - 90 years	1,900	2,700
Total Federal Annual Charges	$ 33,100	$48,300
NON-FEDERAL		
Interest @ 3-1/4%	$ 4,600	$ 4,400
Amortization - 90 years	300	200
Loss in Land Productivity	200	200
Operation and Maintenance	15,000	15,000
Major Replacements	2,000	2,700
Total Non-Federal Annual Charges	$ 22,100	$22,500
Total Annual Cost	$ 55,200	$70,800

TOTAL ANNUAL COST, PHASE I - $126,000

TABLE 16-21

DETAILED COST ESTIMATE
PHASE I - SECTION 1

Item	Unit	Quantity	Unit Cost	Amount
LEVEE				
Clearing and grubbing	Acre	50	$250.00	$ 12,500
Excavation, stripping	C.Y.	36,690	.30	11,000
Excavation, relief drain	C.Y.	7,000	1.50	10,500
Filter Material	C.Y.	25,870	5.00	129,400
Borrow, normal haul	C.Y.	282,740	.50	141,400
Borrow, extended haul	C.Y.	94,250	.60	56,600
Seeding and fertilizing	Acre	50	400.00	20,000
Raising U.S. 60	Job	1	L.S.	7,600
Contingencies				78,000
Subtotal				$467,000
INTERIOR DRAINAGE				
Pumping Plant with Ponding	Job	1	L.S.	$239,000
Gravity Outlets and Appurt.	Job	1	L.S.	20,000
Diversion and Drainage Channels	Job	1	L.S.	10,000
Contingencies				54,000
Subtotal				$323,000
RELOCATIONS				
Raising U.S. 60	Job	1	L.S.	$ 54,000
Utilities (Misc.)	Job	1	L.S.	4,000
Contingencies				12,000
Subtotal				$ 70,000
LANDS AND DAMAGES				
Rights-of-way	Acre	34	$350.00	$ 11,900
Easement, borrow area	Acre	16	100.00	1,600
Severance	Job	1	L.S.	10,000
Subsurface easements	Job	1	L.S.	5,000
Ponding Lands	Job	1	L.S.	5,000
Buildings and Damages	Job	1	L.S.	12,000
Acquisition				6,500
Contingencies				10,000
Subtotal				$ 62,000
TOTAL FIRST COST				$922,000

TABLE 16-22

DETAILED COST ESTIMATE
PHASE I - SECTION 5

Item	Unit	Quantity	Unit Cost	Amount
LEVEE				
Clearing and grubbing	Acre	60	$250.00	$ 15,000
Excavation, stripping	C.Y.	44,700	.30	13,500
Excavation, relief drain	C.Y.	5,650	1.50	8,500
Borrow, normal haul	C.Y.	346,900	.50	173,500
Borrow, extended haul	C.Y.	115,600	.60	69,500
Filter material	C.Y.	28,220	5.00	141,000
Riprap	Job	1	L.S.	15,000
Seeding and fertilizing	Acre	60	400.00	24,000
Ramps & closures	Job	1	L.S.	30,000
Contingencies				98,000
Subtotal				$588,000
INTERIOR DRAINAGE				
Pumping plants	Job	1	L.S.	$400,000
Gravity outlets and appurt.	Job	1	L.S.	60,000
Drainage channels	Job	1	L.S.	10,000
Contingencies				94,000
Subtotal				$564,000
RELOCATIONS				
Gas Lines	Job	1	L.S.	$ 12,000
Utilities (Misc.)	Job	1	L.S.	15,000
Contingencies				5,000
Subtotal				$ 32,000
LANDS AND DAMAGES				
Rights-of-way	Acre	38	$350.00	$ 13,300
Easement, borrow area	Acre	22	100.00	2,200
Severance	Job	1	L.S.	7,500
Subsurface easements	Job	1	L.S.	5,000
Buildings and damages	Job	1	L.S.	40,000
Ponding area	Job	1	L.S.	3,000
Acquisition				10,000
Contingencies				16,000
Subtotal				$ 97,000
TOTAL FIRST COST				$1,281,000

TABLE 16-23

SUMMARY OF FIRST COSTS, PHASE II
(July 1968 Prices)

Item	Cost		
	Section 2	Section 4	Section 6
FEDERAL			
Levees */	$ 390,000	$ 317,000	$ 527,000
Interior Drainage	440,000	635,000	323,000
Contingencies	166,000	188,000	170,000
Engineering and Design	125,000	143,000	127,000
Supervision and Inspection	54,000	62,000	56,000
Overhead	35,000	40,000	36,000
Total Federal First Cost	$1,210,000	$1,385,000	$1,239,000
NON-FEDERAL			
Lands and Damages	$ 53,000	$ 46,000	$ 92,000
Relocations	10,000	30,000	15,000
Contingencies	12,000	15,000	19,000
Supervision and Administration	5,000	4,000	5,000
Total Non-Federal First Cost	$ 80,000	$ 95,000	$ 131,000
Total First Cost	$1,290,000	$1,480,000	$1,370,000

TOTAL FIRST COST, PHASE II - $4,140,000

*/ Includes 250' of floodwall in Section 6

TABLE 16-24

ESTIMATE OF ANNUAL CHARGES, PHASE II
(July 1968 Prices)

Item	Cost Section 2	Cost Section 4	Cost Section 6
FEDERAL			
Interest @ 3-1/4%	$39,300	$45,000	$40,300
Amortization - 70 years	4,700	5,400	4,800
Total Federal Annual Charges	$44,000	$50,400	$45,100
NON-FEDERAL			
Interest @ 3-1/4%	$ 2,600	$ 3,100	$ 4,200
Amortization - 70 years	300	400	500
Loss in Land Productivity	200	200	100
Operation and Maintenance	12,000	11,000	13,000
Major Replacements	1,100	1,400	1,500
Total Non-Federal Annual Charges	$16,200	$16,100	$19,300
Total Annual Cost	$60,200	$66,500	$64,400

TOTAL ANNUAL COST, PHASE II - $191,100

TABLE 16-25

DETAILED COST ESTIMATE
PHASE II - SECTION 2

Item	Unit	Quantity	Unit Cost	Amount
LEVEE				
Clearing and grubbing	Acre	50	$250.00	$ 12,500
Excavation, stripping	C.Y.	38,200	.30	11,500
Excavation, relief drain	C.Y.	4,600	1.50	6,900
Filter material	C.Y.	23,000	5.00	115,000
Borrow, normal haul	C.Y.	293,510	.50	146,800
Borrow, extended haul	C.Y.	97,840	.60	58,800
Riprap, levee	Job	1	L.S.	10,000
Seeding and fertilizing	Acre	50	400.00	20,000
Closure	Job	1	L.S.	8,500
Contingencies				78,000
Subtotal				$468,000
INTERIOR DRAINAGE				
Pumping plant w/o ponding	Job	1	L.S.	$400,000
Gravity outlets and appurt.	Job	1	L.S.	30,000
Diversion and drainage channels	Job	1	L.S.	10,000
Contingencies				88,000
Subtotal				$528,000
RELOCATIONS				
Gas lines	Job	1	L.S.	$ 6,000
Utilities (Misc.)	Job	1	L.S.	4,000
Contingencies				2,000
Subtotal				$ 12,000
LANDS AND DAMAGES				
Rights-of-way	Acre	38	$350.00	$ 13,300
Easement, borrow area	Acre	22	100.00	2,200
Severance	Job	1	L.S.	10,000
Subsurface easements	Job	1	L.S.	5,000
Buildings and damages	Job	1	L.S.	10,000
Ponding lands	Job	1	L.S.	5,000
Acquisition				7,500
Contingencies				10,000
Subtotal				$ 63,000
TOTAL FIRST COST				$1,071,000

TABLE 16-26

DETAILED COST ESTIMATE
PHASE II - SECTION 4

Item	Unit	Quantity	Unit Cost	Amount
LEVEE				
Clearing and grubbing	Acre	50	$250.00	$ 12,500
Excavation, stripping	C.Y.	29,000	.30	8,700
Excavation, relief drain	C.Y.	3,510	1.50	5,300
Borrow, normal haul	C.Y.	238,830	.50	119,400
Borrow, extended haul	C.Y.	79,600	.60	47,800
Filter material	C.Y.	17,560	5.00	87,800
Riprap	Job	1	L.S.	5,000
Seeding and fertilizing	Acre	50	400.00	20,000
Stream diversion	Job	1	L.S.	10,500
Contingencies				63,000
Subtotal				$380,000
INTERIOR DRAINAGE				
Pumping plant with ponding	Job	1	L.S.	$580,000
Gravity outlets and appurt.	Job	1	L.S.	50,000
Drainage channels	Job	1	L.S.	5,000
Contingencies				125,000
Subtotal				$760,000
RELOCATIONS				
Gas lines	Job	1	L.S.	$ 20,000
Utilities (Misc.)	Job	1	L.S.	10,000
Contingencies				6,000
Subtotal				$ 36,000
LANDS AND DAMAGES				
Rights-of-way	Acre	24	$350.00	$ 8,400
Easement, borrow area	Acre	26	100.00	2,600
Severance	Job	1	L.S.	5,000
Subsurface easements	Job	1	L.S.	5,000
Ponding easements	Job	1	L.S.	5,000
Buildings and damages	Job	1	L.S.	15,000
Acquisition				5,000
Contingencies				9,000
Subtotal				$ 55,000

TOTAL FIRST COST - $1,231,000

TABLE 16-27

DETAILED COST ESTIMATE
PHASE II - SECTION 6

Item	Unit	Quantity	Unit Cost	Amount
LEVEE				
Clearing and grubbing	Acre	50	$250.00	$ 12,500
Excavation, stripping	C.Y.	31,750	.30	9,500
Excavation, relief drain	C.Y.	4,310	1.50	6,500
Excavation, channel	C.Y.	3,700	.75	2,800
Borrow, normal haul	C.Y.	231,500	.50	115,800
Borrow, extended haul	C.Y.	77,200	.60	46,400
Filter material	C.Y.	21,560	5.00	107,700
Riprap, levee	Job	1	L.S.	10,000
Seeding and fertilizing	Acre	50	400.00	20,000
Stream diversion	Job	1	L.S.	4,500
Ramps and closures	Job	1	L.S.	120,000
T-wall	L.F.	250	285.00	71,300
Contingencies				106,000
Subtotal				$633,000
INTERIOR DRAINAGE				
Pumping plant w/o ponding	Job	1	L.S.	$300,000
Gravity outlets and appurt.	Job	1	L.S.	20,000
Drainage channels	Job	1	L.S.	3,000
Contingencies				64,000
Subtotal				$387,000
RELOCATIONS				
Utilities (Misc.)	Job	1	L.S.	$ 15,000
Contingencies				3,000
Subtotal				$ 18,000
LANDS AND DAMAGES				
Rights-of-way	Acre	27	$350.00	$ 9,500
Easement, borrow area	Acre	23	100.00	2,500
Severance	Job	1	L.S.	5,000
Subsurface easements	Job	1	L.S.	5,000
Buildings and damages	Job	1	L.S.	50,000
Acquisition				10,000
Contingencies				16,000
Subtotal				$ 98,000
TOTAL FIRST COST				$1,136,000

TABLE 16-28

SUMMARY OF FIRST COSTS, PHASE III
(July 1968 Prices)

Item	Cost Section 3
FEDERAL	
Levees*/	$ 500,000
Interior Drainage	435,000
Contingencies	187,000
Engineering and Design	140,000
Supervision and Inspection	64,000
Overhead	40,000
Total Federal First Cost	$1,366,000
NON-FEDERAL	
Lands and Damages	$ 36,000
Relocations	29,000
Contingencies	13,000
Supervision and Administration	6,000
Total Non-Federal First Cost	$ 84,000
Total First Cost	$1,450,000

TOTAL FIRST COST, PHASE III - $1,450,000

*/ Includes 1,500' of channel change.

TABLE 16-29

ESTIMATE OF ANNUAL CHARGES, PHASE III

(July 1968 Prices)

Item	Cost Section 3
FEDERAL	
Interest @ 3-1/4%	$44,400
Amortization - 50 years	11,200
Total Federal Annual Charges	$55,600
NON-FEDERAL	
Interest @ 3-1/4%	2,700
Amortization - 50 years	700
Loss in Land Productivity	200
Operation and Maintenance	10,000
Major Replacements	1,000
Total Non-Federal Annual Charges	$14,600
Total Annual Cost	$70,200

TOTAL ANNUAL COST, PHASE III - $70,200

TABLE 16-30

DETAILED COST ESTIMATE
PHASE III - SECTION 3

Item	Unit	Quantity	Unit Cost	Amount
LEVEE & CHANNEL				
Clearing and grubbing	Acre	40	$250.00	$ 10,000
Excavation, stripping	C.Y.	51,740	.30	15,500
Excavation, relief drain	C.Y.	3,300	1.50	5,000
Excavation, channel (earth)	C.Y.	192,600	.75	145,000
Excavation, channel (rock)	C.Y.	52,960	1.50	79,500
Filter material	C.Y.	21,380	5.00	107,000
Borrow	C.Y.	190,500	.50	95,000
Riprap, levee	C.Y.	1,850	10.00	18,500
Seeding and fertilizing	Acre	36	400.00	14,500
Stream diversion	Job	1	L.S.	10,000
Contingencies				100,000
Subtotal				$600,000
INTERIOR DRAINAGE				
Pumping plants with ponding	Job	1	L.S.	$350,000
Gravity outlets and appurt.	Job	1	L.S.	50,000
Diversion and drainage channels	Job	1	L.S.	35,000
Contingencies				87,000
Subtotal				$522,000
RELOCATIONS				
Gas lines	Job	1	L.S.	$ 24,000
Utilities (Misc.)	Job	1	L.S.	5,000
Contingencies				6,000
Subtotal				$ 35,000
LANDS AND DAMAGES				
Rights-of-way, levee & channel	Acre	34	$350.00	$ 11,900
Easement, borrow area	Acre	11	100.00	1,100
Severance	Job	1	L.S.	10,000
Subsurface easements	Job	1	L.S.	5,000
Ponding lands	Acre	30	100.00	3,000
Acquisition				5,000
Contingencies				7,000
Subtotal				$ 43,000
TOTAL FIRST COST				$1,200,000

16. DEVELOPMENTAL INVESTMENT AND ANNUAL COSTS

Investment costs are based on data presented in paragraph 8 of this Chapter. For computational convenience, the total costs required to support the total employment percent were estimated, then a cost to support that increment employment which could be expected to occur in the absence of the Midland LPP project. In consonance with the principle of assigning costs on an incremental basis, the relevant costs are considered to be the difference in cost with and without the project. Federal, non-Federal, and total public and quasi-public investments are shown by decade and by item on table 16-31. Cumulative costs on a with or without basis are presented in table 16-32. Net costs are utilized in subsequent analysis of performance indices. Projected expenditures for 10-year intervals were made for the developmental plan from 1970 through 2020. These projections were made for both Federal and non-Federal investments. All investments were assumed to be uniform during each year of the 10-year intervals. Federal investments were classified entirely as public, with an estimated useful life of 50 years. Non-Federal investments were broken down into the following categories: residential, public, industrial and commercial. Residential and public are assumed to have useful lives of 50 years. Industrial and commercial are assumed to consist of 50 percent equipment, with a 25-year useful life, the remainder having a 50-year life. Major replacements were phased in for both Federal and non-Federal investments in accord with these assumptions for the 100 year project life. Structures constructed in 1980 were replaced in 2030 in order to maintain the physical plant until 2070. All yearly investments were converted to present worth values by use of a 3-1/4 percent interest rate. The total 1970 present worth of Federal and non-Federal investments were then spread over the project life at 3-1/4 percent and 5 percent interest rates, respectively.

TABLE 16-31

PUBLIC AND QUASI-PUBLIC DEVELOPMENTAL INVESTMENTS (FEDERAL AND NON-FEDERAL) 1/

Item	1980	1990	2000	2010	2020
	(Cumulative in $1,000)				
Elem. School (Fed)	265	265	265	265	265
(N-Fed)	795	1,613	2,554	3,508	4,780
High School (N-Fed)	291	534	795	1,038	1,410
University (Fed)	7,698	7,698	7,698	7,698	7,698
(N-Fed)	7,698	16,418	23,695	29,540	34,051
Hospital (Fed)	1,092	1,911	3,058.5	4,014	5,733
(N-Fed)	1,092	1,911	3,058.5	4,014	5,733
Retard. Center (Fed)	11,329	12,191	13,139	14,182	15,330
(N-Fed)	5,911	6,773	7,721	8,764	9,911
Public Bldgs. (Fed)	1,200	2,539	4,038	5,649	7,900
(N-Fed)	1,876	3,972	6,315	8,836	12,357
Gen. Rec. (Fed)	251	440	704	924	1,320
(N-Fed)	63	110	176	231	330
Golf Course (Fed)	255	255	255	255	255
(N-Fed)	--	180	180	180	180
Sewer & Water (Fed)	1,721	3,550	5,700	7,636	10,755
(N-Fed)	430	887	1,425	1,909	2,689
Fish Hatchery (N-Fed)	600	600	600	600	600
Fire Prot. (Fed)	62	62	62	62	62
(N-Fed)	94	94	172	250	328
Airport (N-Fed)	--	1,350	1,350	1,350	1,350
Railroad (N-Fed)	240	240	240	240	240
Highways (Fed)	4,872	7,016	10,120	12,040	14,552
(N-Fed)	1,218	1,754	2,530	3,010	3,638
Utilities (N-Fed)	2,243	4,491	7,306	10,422	14,394
Rec.-Forest Svc. (Fed)	10,073	14,874	18,638	20,249	22,500
Total Non-Federal	22,551	40,927	58,117.5	73,892	91.991
Total Federal	38,818	50,801	63,677.5	72,974	86,370
TOTAL 2/	61,369	91,728	121,795	146,866	178,361

1/ Table 16-10 in Section II shows the combined totals
2/ Does not include local protection costs.

TABLE 16-32

NET DEVELOPMENTAL INVESTMENTS COSTS
AND ANNUAL CHARGES ($1000)

Item	Federal	Non-Federal	Total
Total Investment (with)	86,400	545,100	631,500
(without)	61,900*/	181,600*/	243,500
Net Investment Cost	24,500	363,500	388,000
Present Worth, including Major Replacements (with)	62,400	302,300	364,700
(without)	50,400	119,300	169,700
Net P. W. inc. Replacements	12,000	183,000	195,000
Annual Charges (with)	2,110	15,230	17,340
(without)	1,710	6,010	7,720
Net Annual Charges	400	9,220	9,620

*/ The Federal-non-Federal split between total Developmental Investments without local protection was made using identical methodology used to make similar divisions for the "with" situation (Table 16-31). A table similar to Table 16-31 for the "without" condition has not been included in this report.

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SECTION V - BENEFITS

17. SUMMARY

Tangible benefits credited to the proposed flood control system consist of user and expansion benefits. User benefits, the value of damages prevented and land enhancement, are considered to be a direct result of the system and a measure of net efficiency gains; and as such, are credited to both the regional and national accounts. Expansion benefits, wages and salaries and return on industrial and commercial investments, are assigned to the regional and national accounts dependent upon the degrees in which they relate to national efficiency and income redistribution.

Benefits arising from the total investment package, Federal and non-Federal, are presented in table 16-33.

TABLE 16-33

SUMMARY OF GROSS BENEFITS RESULTING
FROM REALIZATION OF MIDLAND'S
TOTAL DEVELOPMENTAL POTENTIAL

Category and Class of Benefit	Annual Benefits ($1000)				
	National Account Only	Regional Account Only	National & Regional Accounts	Total National Account	Total Regional Account
User Benefits					
Flood Control	-	-	52	52	52
Enhancement	-	-	12	12	12
Total	-	-	64	64	64
Expansion Benefits					
Redevelopment	-	11	7	7	18
Development - wages	-	132,486	33,678	33,678	166,164
Total	-	132,497	33,685	33,685	166,182

Benefits assigned in this study are net of project-induced costs and associated costs necessary for benefit realization. Induced and associated costs were analyzed as negative user benefits and have not been included in tables 16-33 and 16-34.

TABLE 16-34

SUMMARY OF NET CREDITABLE BENEFITS
RESULTING FROM INSTALLATION OF LOCAL
PROTECTION WORKS AT MIDLAND

Category and Class of Benefit	Annual Benefits ($1,000) National Account Only	Regional Account Only	National & Regional Accounts	Total National Account	Total Regional Account
User Benefits					
Flood Control	-	-	52	52	52
Enhancement	-	-	12	12	12
Total	-	-	64	64	64
Expansion Benefits					
Redevelopment	-	11	7	7	18
Development - wages	-	76,091	16,271	16,271	92,362
Total	-	76,102	16,278	16,278	92,380

Benefits presented in table 16-34 result from an analysis of the Midland area's developmental potential without additional */ flood protection work vs. its potential with local flood protection provided. Benefits given in table 16-34 are the net difference between these two potentials and are credited to the local protection works considered at Midland. Periods of analysis used in this study are of particular importance and have been discussed in Section IV of this Chapter. The 90-, 70-, and 50-year levee lives result from the 100-year economic life assigned to the total study period. Justification for the 100-year upper limit lies in the increasing uncertainty involved in predicting the more remote future and in the likelihood that any benefits and costs accruing beyond a 100-year cutoff would be largely offsetting in their amounts. Because of the low present worth of remote benefits, any benefits accruing beyond a 100-year period would have an insigni-icant effect on the benefit-cost estimates.

*/ Considers Cave Run Reservoir and USDA tributary structures to be in operation for development potential without proposed levees.

18. USER BENEFITS

User benefits assigned to the Midland project are the assessed values of goods and services directly resulting from the project, less associated costs incurred in realization of the benefits and less any induced costs not included in the project costs. Thus user benefits resulting from levee construction for the purpose of flood control are the value of damages prevented and the enhanced value of portions of the flood plain lands. Derivation of user benefits credited to the proposed local protection project is presented in detail by the ensuing discussion.

Flood Control - Extent and Character of the Flood Plain - The overflow area of the Licking River, between river miles 154± and 173±, designates the Midland flood plain area for the purpose of flood control benefit analysis. Of the 8,200 acres comprising the Midland flood plain area (limited by the standard project flood limit) approximately eighty percent is devoted to agricultural crop and non-crop use with corn, hay, and tobacco being the major crops. Although productivity is generally higher in the flood plain than in adjacent upland areas, frequent flooding and small acreage ownerships contribute to the relative inefficiency and low productivity characteristic of the Appalachian Region. Urban development consists of the small communities of Farmers, Midland, and Salt Lick. The 30 miles of transportation routes which presently traverse the flood plain are composed of portions of U. S. Highway 60, State Routes 211, 801, and 826, other medium and light duty roads, and the Chesapeake and Ohio Railroad. Right-of-way work and bridge construction is in process for Interstate Highway 64 which crosses the flood plain at river mile 162±. Estimated number of units and value of property within the February 1962 flood limits in the study area are presented in table 16-35.

TABLE 16-35

NUMBER OF UNITS AND PROPERTY VALUES
(Midland Area, 1962 Flood Limits)

Area and Property Category	Units 1/	Property Value ($1,000)	Damage for Flood Recurrence May 1961 ($1,000)	Feb 1962 ($1,000)
Inside Levee Sections 1 and 5				
Agriculture	660 ac.	231.0	8.5	4.9
Structures	41	561.9	3.0	37.0
Trans. Rts.	2.0 mi.	50.2	.4	3.3
Subtotal		843.1	11.9	45.2
Inside Levee Sections 2, 4 and 6				
Agriculture	460 ac.	161.1	10.1	5.7
Structures	105	1,615.2	10.0	220.0
Trans. Rts.	6.7 mi.	172.6	1.2	11.2
Subtotal		1,948.9	21.3	236.9
Inside Levee Section 3				
Agriculture	175 ac.	61.3	10.3	5.9
Trans. Rts.	-	-	-	-
Subtotal		61.3	10.3	5.9
Unprotected				
Agriculture	5,305 ac.	1,856.8	102.0	58.3
Trans. Rts.	11.5 mi.	296.3	2.1	19.3
Subtotal		2,153.1	104.1	77.6
Total Area		5,006.4	147.6	365.6

1/ For February 1962 flood.

Flood Damages - Data used to develop agricultural and urban flood damage estimates for the Licking River are based on field surveys conducted in 1961 and 1963. Development of flood damages to crop, non-crop, and transportation route categories necessitated the use of flood profiles, inundated areas, land use, crop values, and unit damage curves. Elevation-area inundated curves were developed by placing several actual or synthetic flood lines covering the range of flooding on topographic maps and determining the area within each of the flood lines, exclusive of the normal stream channel. These areas were then related to the comparable elevation at the control gage for each study section. Adjustment of 1968 values and conditions of development was effected by reconnaissance of the area and concurrent office studies.

Basic data were compiled by individual study sections as identified by the phased levees shown on exhibit 16-1. Under present conditions of development, recurrence of the flood levels experienced in May 1961 and February 1962 would cause damage estimated to be $147,600 and $365,600, respectively. Detailed damages for the above mentioned floods are presented as a part of table 16-35. Sample elevation-damage curves for urban, agricultural and transportation routes are presented as exhibits 16-10, -11, and -12. These curves represent damages expected to occur in the composite area to be afforded protection by Levee Sections 1 and 5 in 1968, 1980 (Phase I), and 2070. The composites of these three property damage categories are shown on exhibit 16-13.

Average Annual Damages - Average annual damages were computed by use of the frequency-damage method. Detailed computations were made for each property category by study section and composited for presentation in this report.

Average annual damages in the flood plain study area, 1968 values and conditions of development, amount to $234,000 under natural conditions. Reductions expected by the completion of Cave Run Reservoir (1970±) and USDA tributary structures (1980) yield residual average annual damages of $97,900 and $46,300, respectively. It is noted that the Cane Run General Design Memorandum stated that residual damages in the reach immediately below the dam (mile 173.5 to mile 144.3) were based on nearly complete retardation of flood flows within this reach. Revised hydrologic data on dischanges from Triplett Creek indicate increased flood stages in this area. Increased urban average annual damages at Farmers and Salt Lick account for the major increase to $97,900.

Conditions as modified by Cave Run Reservoir and USDA structures become the defined natural conditions for study of the phased levee system. Average annual damages of $3,700 (1968 values and conditions of development) for the sample area */ are shown by frequency-damage curve No. 1, of exhibit 16-14.

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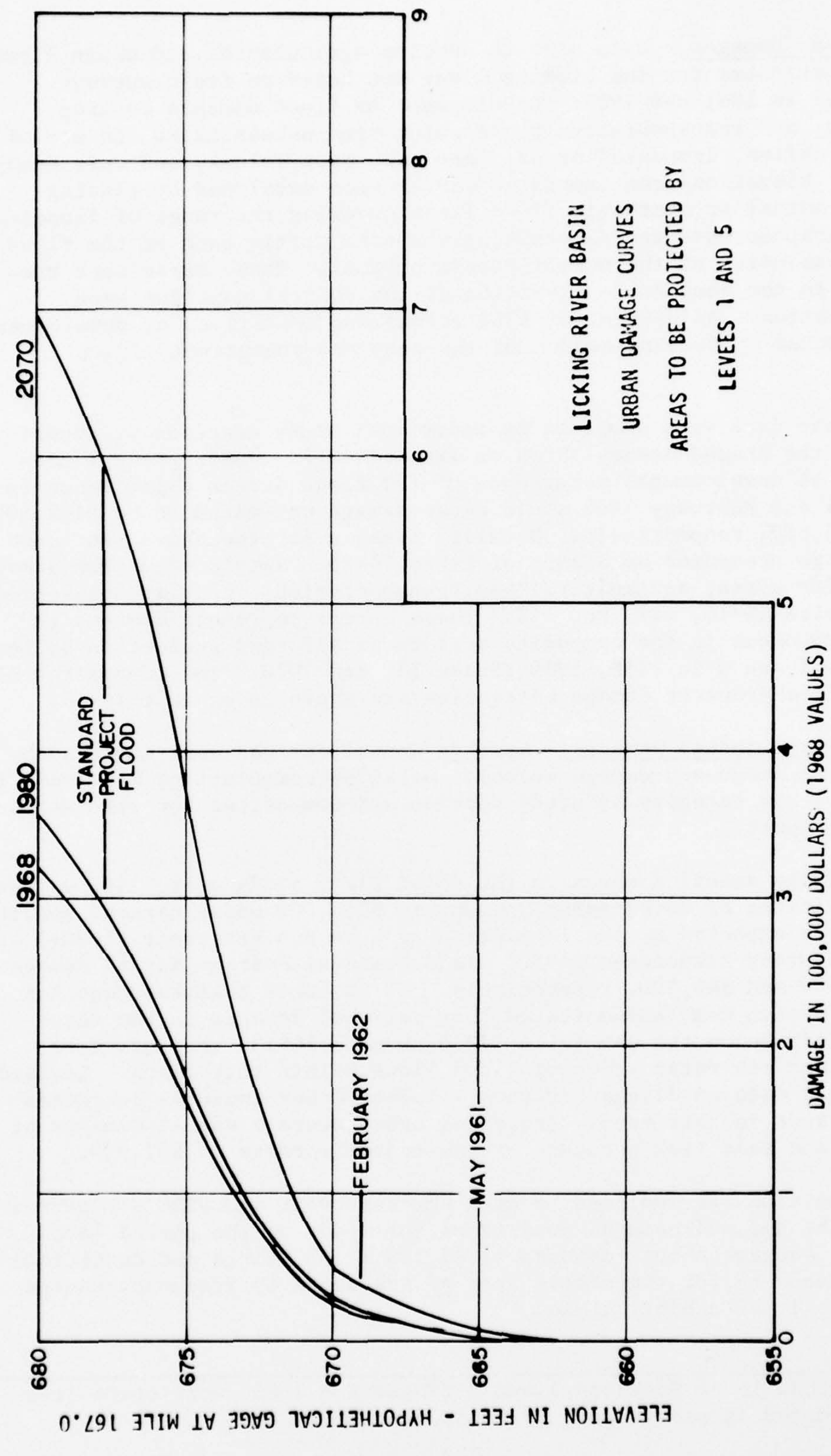
*/ Areas within Levee Sections 1 and 5 (Phase I - 1980) were composited and presented as sample data for this report.


LICKING RIVER BASIN
URBAN DAMAGE CURVES
AREAS TO BE PROTECTED BY
LEVEES 1 AND 5
2070
1980
1968
STANDARD PROJECT FLOOD
FEBRUARY 1962
MAY 1961
ELEVATION IN FEET - HYPOTHETICAL GAGE AT MILE 167.0
DAMAGE IN 100,000 DOLLARS (1968 VALUES)
680
675
670
665
660
655
0
1
2
3
4
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7
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9

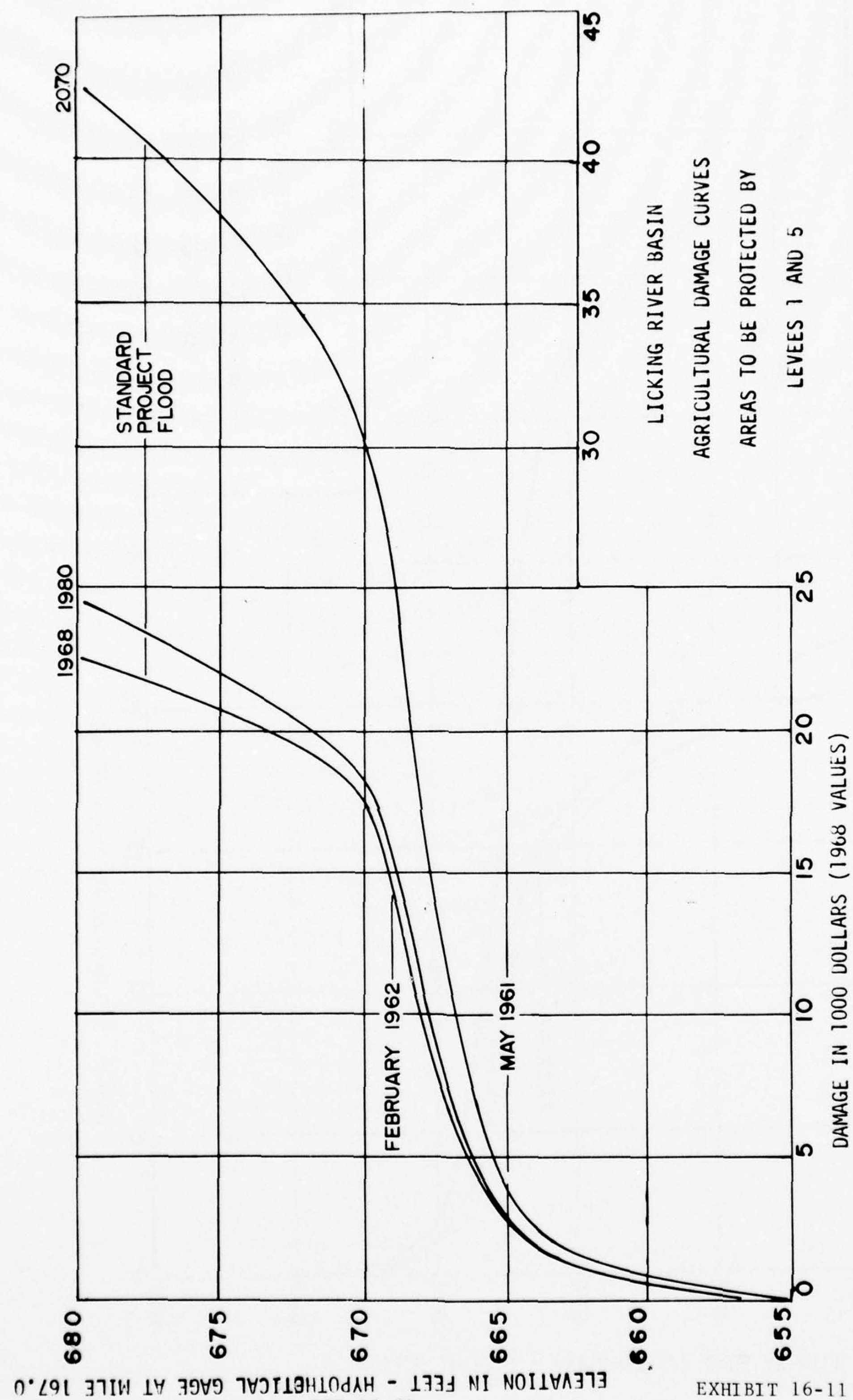
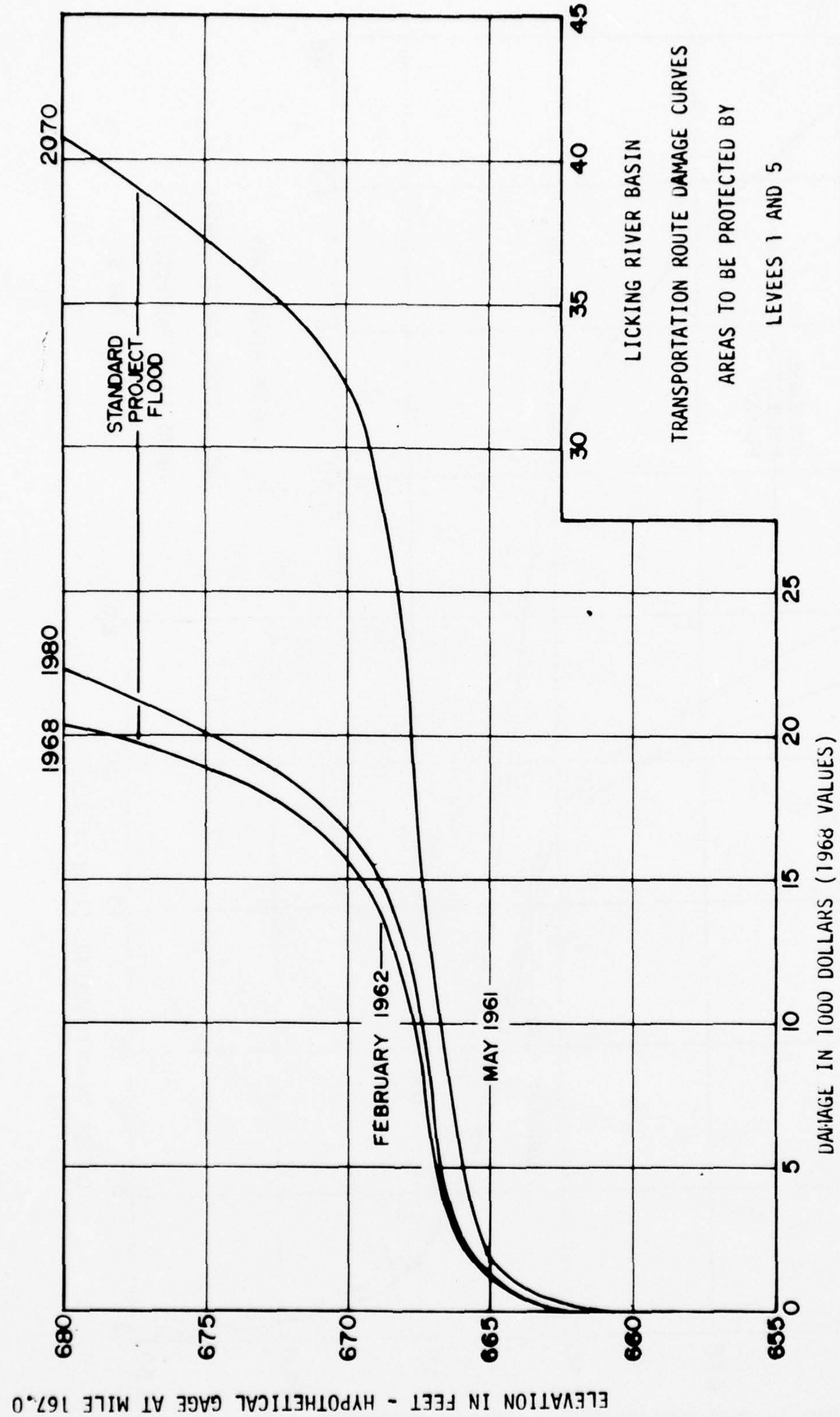


EXHIBIT 16-11



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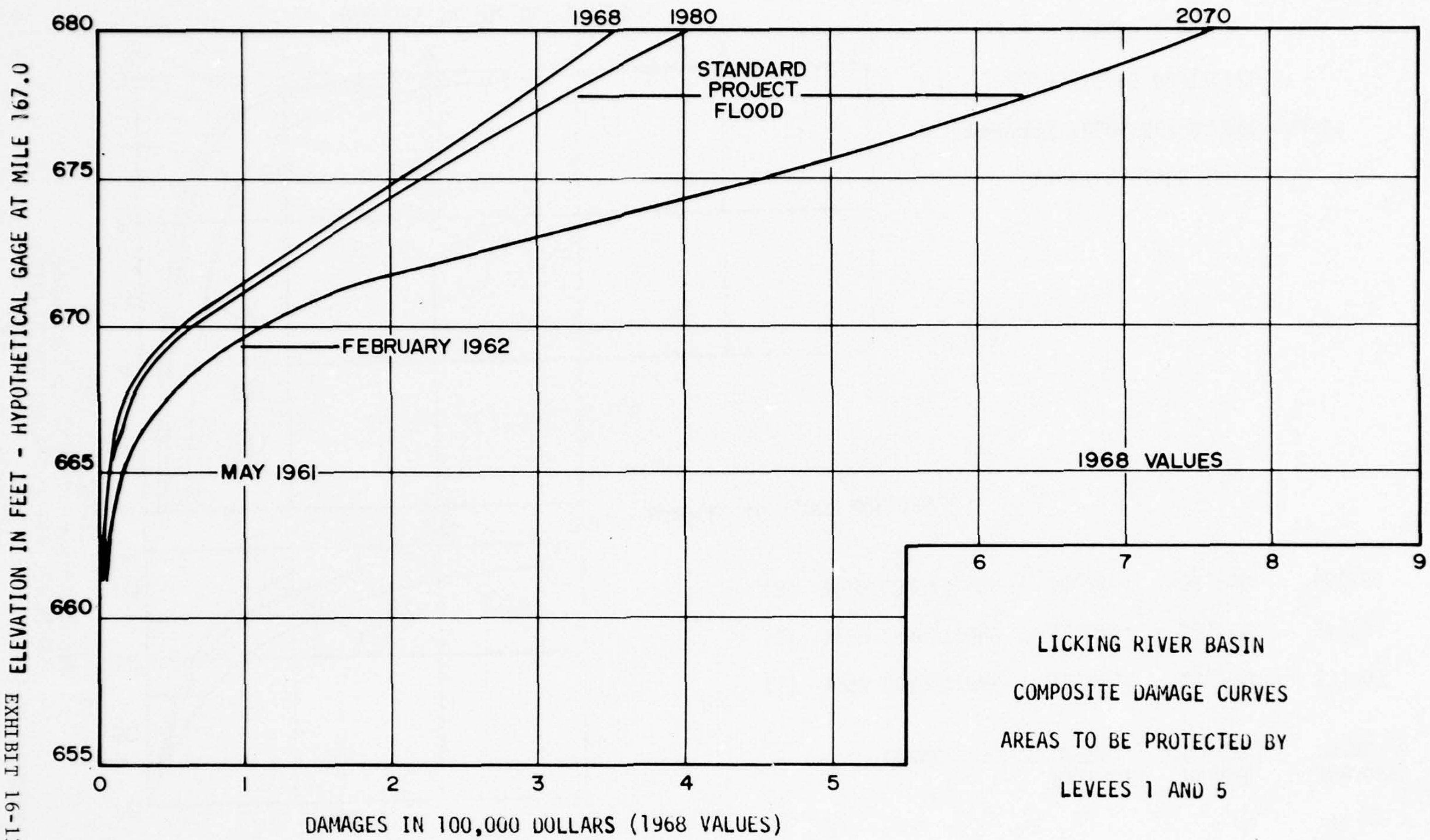
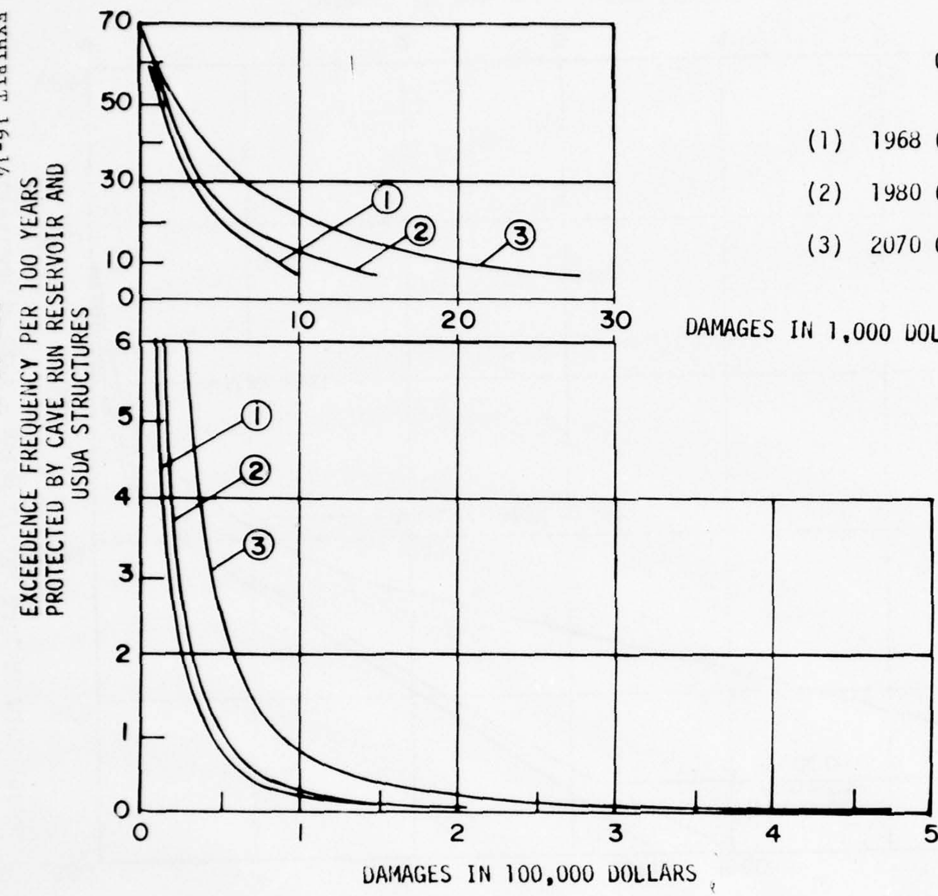


LICKING RIVER BASIN
COMPOSITE DAMAGE CURVES
AREAS TO BE PROTECTED BY
LEVEES 1 AND 5

EXHIBIT 16-13

EXHIBIT 16-14



CURVE	AVERAGE UPPER	ANNUAL LOWER	DAMAGES TOTAL
(1) 1968 CONDITIONS	$2,000	$1,700	$3,700
(2) 1980 CONDITIONS	$2,540	$2,250	$4,790
(3) 2070 CONDITIONS	$4,260	$4,000	$8,260

LICKING RIVER BASIN

COMPOSITE FREQUENCY-DAMAGE CURVES

AREAS TO BE PROTECTED BY

LEVEES 1 AND 5

Flood Control Benefits: Present Development - Flood control benefits to present development, within the 8,200-acre Midland flood plain, were based on the elimination of damages to areas considered for levee protection. For this study, present development is defined as that development expected to be in existence within the protected areas at the time of each phased construction period. The methodology presented below shows how flood damage prevention benefits to developments present in 1980 were determined. This analysis is a sample of how similar benefits to development expected to be present in 2000 (Phase II) and 2020 (Phase III) were derived. The methodology is presented by steps as set out below.

Step 1 - Elevation-damage curves reflecting 1968 conditions and values were projected to reflect 1980 conditions (see exhibits 16-10 thru 13). The methodology used to make these projections is defined in the paragraph immediately subsequent to this analysis.

Step 2 - Having established the composite 1980 damage curve (exhibit 16-13) a standard frequency-damage analysis was made to determine that average annual damages to 1980 development would be $4,790 (exhibit 16-14).

Step 3 - Throughout the period of analysis the study area's economy is expected to expand. This expansion will result in an increase in real per capita income which in turn will be reflected in added values to flood plain area properties and to a proportionate increase in flood damages. To account for this increase in flood damage prevention benefits an economic increase adjustment (EIA) over the twelve-year period (1968-1980) has been added to average annual damages to 1980 development. Determination of the adjustment made for (EIA) is based upon expected increases in real per capita income which has been projected to grow at 2% compounded annually. Based upon this growth rate, real per capita income within the study area is expected to increase by about 29% between 1968 and 1980. Therefore, average annual damages expected to occur under 1980 conditions have also been increased by 29%. An analysis of damages to development present in 1980 is given by the calculations shown below and is illustrated graphically by figure 16-14.

(1) AAD in 1980, including FG from 1968 to 1980 only (no EIA) = $4,790 (from exhibit 16-14)

(2) Plus EIA from 1968 to 1980 = (.30)($3,480) 1/ = $1,020

(3) AAE benefits from 1980 to 2070 = $4,790 + $1,020 = $5,810

(4) Spread over period from 1970 to 2070:
= ($5,810)(29.03937) 2/ (.72627) 3/ (.03388) 4/
= ($5,810)(.71454) = $4,150

Meaning of Terms -

AAD = Average Annual Damages
FG = Future Growth
EIA = Economic Increased Adjustment
AAE = Average Annual Equivalent

1/ AAD to urban properties and transportation facilities in 1980 including FG from 1968 to 1980 but excluding agricultural damages.

2/ 29.03937 = accumulated present worth factor 90 years @ 3¼%

3/ .72627 = present worth factor 10 years @ 3¼%

4/ .03388 = interest and amortization 100 years @ 3¼%

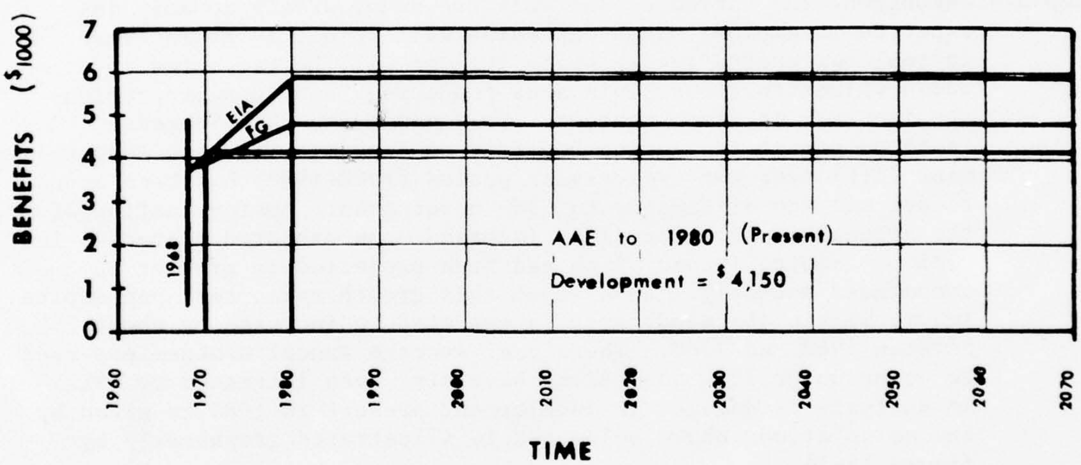


Figure 16-14. Average Annual Benefits to Development Present in 1980 (period of analysis 1970 to 2070 - 3¼% interest).

Benefits from Phase II (2000) and Phase III (2020) levees were based on residual average annual damages, as modified by the applicable frequency curves of exhibit 16-6, and derived in a manner similar to the Phase I (1980) benefits. Average annual equivalent benefits, of $27,300, to existing development are included as part of table 16-36 for the composite of all levees.

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TABLE 16-36

SUMMARY OF USER BENEFITS
MIDLAND LOCAL PROTECTION PROJECT

Item of Benefit	Total Project Benefits 1/
Flood Control Benefits	
AAE benefits to existing development 2/	$27,300
AAE of incremental development	1,400
AAE of economic increase adjustment	22,800
Subtotal Flood Control Benefits	$51,500
Enhancement	12,000
Total User Benefits	$63,500

1/ Benefits for items are present value of average annual equivalent (AAE) benefits for all levees. (Discounted to 1970).

2/ Development existing at time construction begins on each levee, discounted to 1970 AAE.

Future Development - Benefits will accrue to the project as a result of normal future development expected to locate in the flood plain irrespective of project construction. Population projections made by the Office of Business Economics for the Appalachian region provided guidelines for projecting future urban development. Population projections for the nine-county study area based upon historical trends are presented on figure 16-2. As a result of conditions prevailing in both the immediate and general area positive growth has been predicted for the flood plain, irrespective of project construction. Expansion of commercial development is forecast as a result of the economic impact of Cave Run Reservoir, which is presently under construction, the authorized Falmouth Reservoir, and the USDA Reservoirs. Future growth, out of necessity, must occur in or near the flood plain due to lack of other level lands suitable for development. A growth rate of 200 percent was used for the area below Cave Run Reservoir in the Cave Run General Design Memorandum. Recently published population guidelines by OBE provided more adequate parameters for determination of applicable growth. Accordingly future growth factors were applied incrementally over the flood plain profile, increasing from 0 to 150 percent (over the 100-year period of analysis) for urban and

transportation route damages. Straight line growth was assumed overtime for the intermediate projections in 1980, 2000, and 2020. Estimates of flood control benefits (excluding crop benefits) were further adjusted to include the secular trends in real per capita output expected to occur during the project life from an expanding economy accompanied by increased productivity and investment. This increase would be reflected in added values to properties and contents in the overflow area resulting in proportionate increases in flood damage prevention benefits. Real per capita personal income is projected to increase at a rate of two percent compounded annually. Both present and future development benefits were adjusted to include this economic expansion.

Agricultural yield increases utilized a 0 to 100 percent increment over the flood plain profile. This growth curve was derived from a comparison of OBE and Ohio River Basin Comprehensive projections for agricultural areas, and an adjusted average used for agricultural projections. Increased productivity was assumed, based on the continued trend in increased acres per owner and resulting from more efficient land use, to the extent of flood frequency limitations prevailing at the lower elevations.

Sample computations defining the methodology utilized for determining flood damage prevention benefits from future growth and the economic increase adjustment to the future growth benefits are presented below by steps. These computations show average annual benefits from prevention of flood damages to growth between 1980 and 2070, inclusive, and average annual benefits resulting from the economic increase adjustment to these future growth benefits. Sample flood damage prevention benefit computations reflecting 1980 conditions and values have been presented previously. The future growth computations furnished below will complete the sample flood damage prevention benefit presentation.

Step 1 - Elevation damage curves reflecting 1968 conditions and values were projected upward to reflect 2070 conditions (see exhibits 16-10 through -13). Average annual damages in 2070 are estimated to be \$8,260 (from exhibit 16-14). However, this AAD does not account for the economic increase adjustment from 1968 to 1980.

Step 2 - Assume straight line growth between 1980 and 2070. Further, assume that 2070 AAD would increase by an amount equal to the economic increase adjustment from 1968 to 1980. By this latter assumption 2070 average annual damages prevented will be equal to \$8,260 plus \$1,020 or \$9,280.

Step 3 - Determine the average annual equivalent value of a gradient series from \$5,810 in 1980 to \$9,280 in 2070 over a 100-year period from 1970 at a 3½% interest rate as follows:
(\$9,280-\$5,810)(.2641)(29.03937)(.72627)(.03388)
= (\$3,470)(.18871) = \$655

Average annual benefits to future development between 1980 and 2070 are \$655. The assumptions and computations utilized to

arrive at this amount are shown graphically in figure 16-15

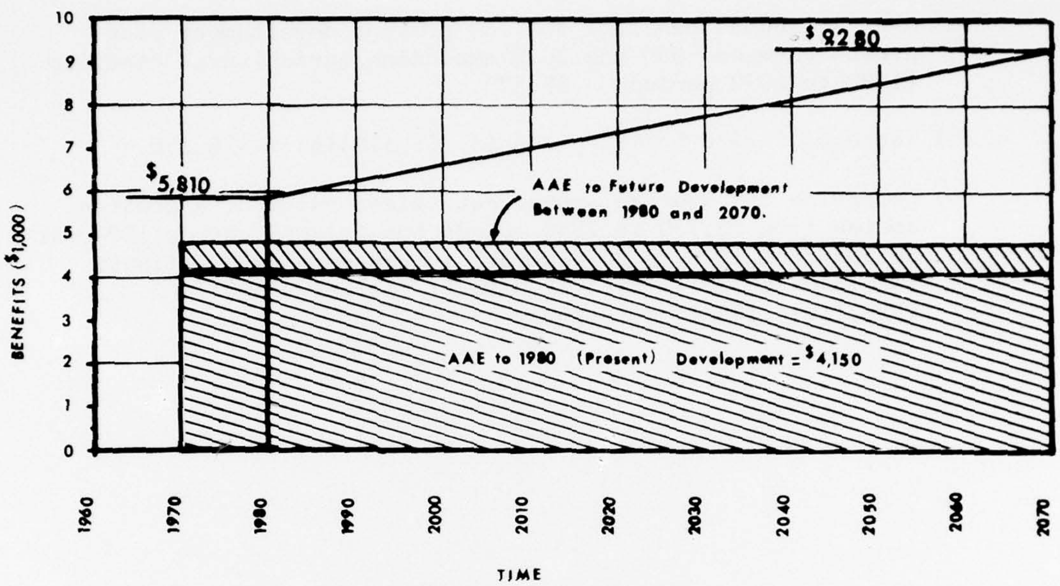


Figure 16-15 Average Annual Benefits to Future Development Between 1980 and 2070.

Step 4 - To this point benefits to 1980 (present) development and benefits to development expected from 1980 to 2070 have been calculated. An economic increase adjustment was included in benefits to 1980 development. Such an adjustment must be added to future growth benefits between 1980 and 2070. As previously discussed, the economic increase adjustment is based on increases expected in real per capita income. This parameter is expected to increase from a 1980 base index of 100 to an index of 500 in 2070, a net increase of 400 percent. This projection is on the conservative side of the 2% compound growth presently assumed for real per capita income growth. The analysis for economic increase adjustment from 1980 to 2070 is furnished by the following computations and shown graphically on figure 16-16.

(1) Average annual benefits to 1980 (present) development (1980-2070 period) = $5,810.

(2) Average annual benefits to growth between 1980 and 2070 (1980-2070 period) = \$920.

(3) Average annual benefits to 1980 present development plus growth between 1980 and 2070 (1980 to 2070 period) = \$6,730.

(4) Average annual benefits to 1980 present development plus growth between 1980 and 2070 excluding agricultural benefits (1980 to 2070 period) = \$5,370.

(5) Increase \$5,370 by 400 percent: (\$5,370)(5) = \$26,850.

(6) Determine the average annual equivalent value of a gradient series from \$6,730 in 1980 to \$26,850 in 2070 over a 100-year period from 1970 to 2070 at 3½% interest rate as follows:
(\$26,850-\$6,730)(.2641)(29.03937)(.72627)(.03388) =
(\$20,120)(.18871) = \$3,800.

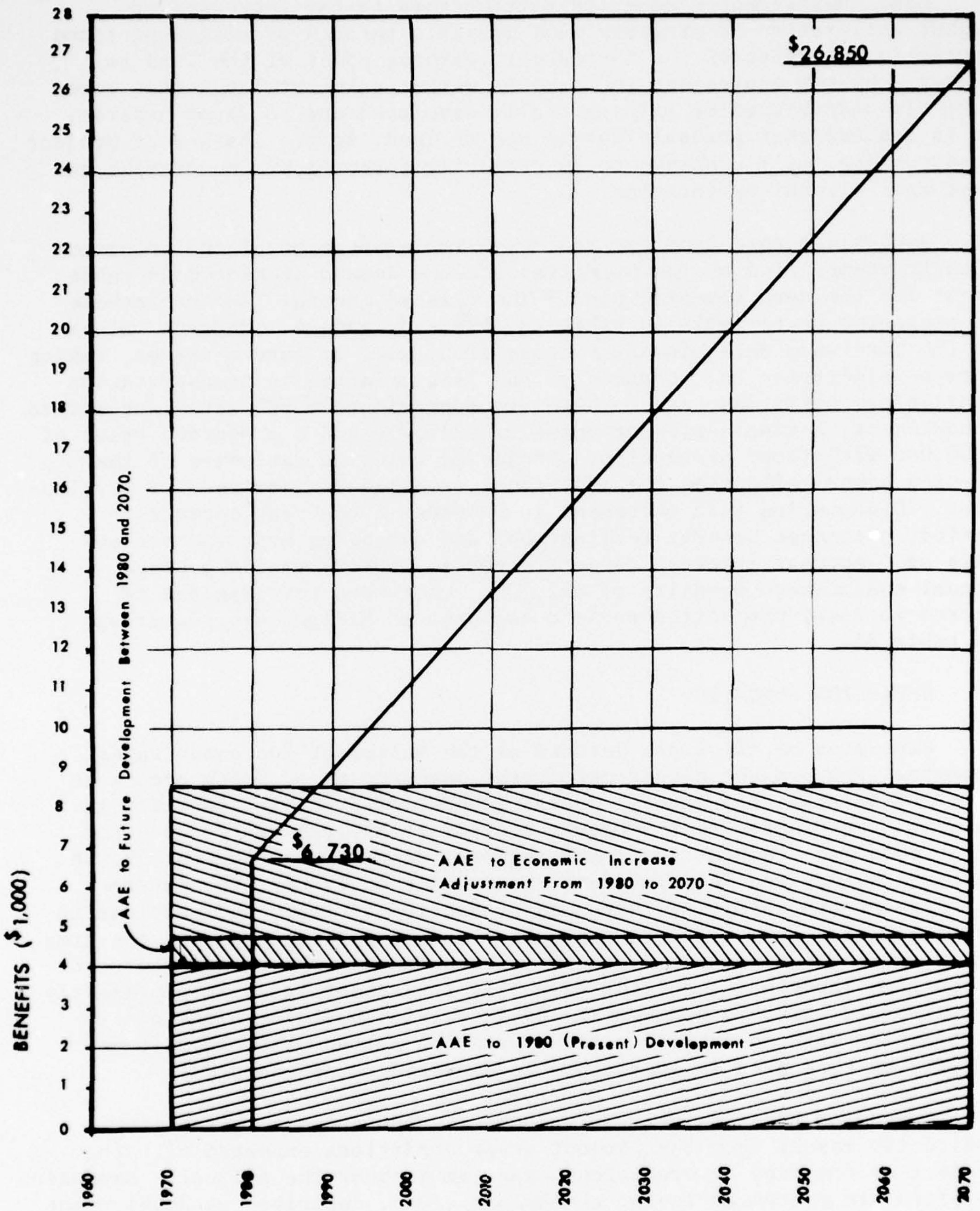


Figure 16- 16 Average Annual Benefits to Economic Increase Adjustment and Total Benefits.

Land Enhancement - Benefits attributable to the increased or higher utilization of property made possible through provision of flood protection, consist of the increase in earning power of the land as measured by the equivalent increase in market value of lands that were formerly undeveloped or only partially developed due to flood hazards. It is assumed that probable future use of land, in the absence of project construction, will continue to be primarily directed by the present and past agricultural orientation.

Probable future land use following implementation of the proposed plan is exemplified by the potential acreage demand presented in table 16-11 for the developmental plan. The related general land use scheme is presented pictorially on exhibits 16-2, -3, and -4. Current values of the land were determined and projections made of future values, taking into consideration the location of the land relative to transportation facilities, utilities, etc. There are approximately 593 acres subject to enhancement, having a present value of $237,200 and a projected value of $890,000 with flood protection. Projected value is exclusive of the earning power reflecting the additional investments required for development. Discounting this increment to consider a ten-year conversion period, postponed benefit realization, and spreading over the project life at 5 percent interest rates (factor = .05038), yields average annual enhancement benefits of $12,000. User benefits expected to accrue to local protection works considered at Midland are summarized in table 36.

19. EXPANSION BENEFITS

Expansion benefits are defined as the values of increased wages stemming from project construction, the measurement of which occurs in terms of salaries and wages. The assignment of expansion benefits is based on the premise that projects similar to Midland can do much for early economic stimulation of the regional economy and long run growth. The premise derives from the fact that public investment in resource development can result in increased production of goods and services in Appalachia for both regional and national consumption, provided the area served by the investment is otherwise competitive. By the provision of flood free lands and a nucleus of public investment in an area presently deficient in suitable commercial and industrial building sites and in combination with an expanding transportation system, the competitive ability of this area in Appalachia is expected to be enhanced.

Expansion benefits are the values of goods and services which indirectly result from the project under conditions expected with the project as compared to conditions expected without the project. Expansion benefits are presented in two components. One, described as development benefits, is measured in terms of wage and salary and other income flows

generated by the area development plan. These benefits, attributable to both water project and associated public investments, are creditable in varying degree to the national and regional accounts. The second component, identified as redevelopment benefits, is measured in terms of the wage and salary components of expenditures for construction, operation, and maintenance of the water control resource projects. The increase of wages and salaries accruing to persons who otherwise would be unemployed or underemployed is creditable to both the national and regional accounts and the remainder only to the regional account.

A comprehensive study of the present economic base, future contributive potential, and project impact for the Midland project's area of influence, was conducted by Spindletop Research Service, in conjunction with the University of Kentucky and Corps of Engineers' analyses. Basic data from these studies were used in the derivation of project expansion benefits.

Developmental Expansion Benefits - Assignment of developmental expansion benefits to the proposed water resource plan, necessitates an analysis of the developmental investment potential with and without the proposed plan of flood protection. Hence, the direct indication of project impact is the increment in benefits initiated by the provision of flood protection measures as an element in the total development plan. The extent of potential development with flood protection provided, has been presented thus far as the developmental objective. The potential development would be substantially reduced without local flood protection. Failure to provide local flood protection at Midland would limit the size of the industrial district and reduce Midland's development potential as shown in table 16-37. The smaller acreage available for residential purposes substantially reduces the population potential of Midland. Potential wages and private investments would be proportionately less under this development alternative.

TABLE 16-37

MIDLAND DEVELOPMENTAL POTENTIAL
UNDER ALTERNATIVE PLANS

Categories	Alternative A - No Further Flood Protection 2/ 1980	Alternative A - No Further Flood Protection 2/ 2020	Alternative B - Phased Flood Protection 1980	Alternative B - Phased Flood Protection 2020
Employment	3,500	9,600	4,900	24,000
Wages (million $) 1/	30	130	42	326
Population	4,100	12,000	4,700	30,000
Investments ($1,000)				
Public	56,209	95,095	59,126	163,967
Quasi-Public	1,592	5,758	2,243	14,394
Private	23,460	142,690	39,485	453,179
Total	81,261	243,543	100,854	631,540

1/ Level of wages for a specific development year. Figures not cumulative.

2/ No flood protection other than Cave Run Reservoir and USDA structures.

The annual investments used in deriving developmental expansion benefits were assumed to be uniform throughout each decade. Economic life of the project is computed as 100 years. Investments were discounted at a 3-1/4 percent interest rate to 1970 to obtain present values. In order to assure a 100-year economic life, replacement of investment was developed by use of the following schedule:

Public .... 50 years

Residential .... 50 years

Industrial and Commercial
Buildings (50% of investment) .... 50 years

Equipment (50% of investment) .... 25 years

In the second 25 years, the investment to be discounted represents a stacked investment, composed of an initial investment plus a replacement investment. After the first 50 years of project life the investment to be discounted is represented entirely by replacement investment.

Net developmental expansion benefits, resulting from the investment increment made possible by provision of local flood protection works defined herein are presented as a part of table 16-41.

Employment and Wages - While positive growth is forecast by economic base studies without the Appalachian Development Program, the nine-county area's heavy out-migration and cyclical unemployment are expected to contribute heavily toward its lag behind Appalachian and national growth rates. Employment and population projections for OBE sub-regions 9, 12, and 13 provided guidelines for the nine-county projections. Normal and benchmark projections for the nine-county labor market area were derived by disaggregation of the respective sub-regions. The developmental plan has been designed to utilize the unique combination of resources in a manner which results in net national and regional efficiency gains, while increasing employment and income opportunities, and stabilizing the population.

Midland employment forecasts were developed separately for basic and service employment groups. Basic employment, which includes jobs in medical, university, tourism, and manufacturing facilities, is identified as playing a key development role in Midland's economy. Potential basic employment forecasts, developed by Spindletop Research Service, were determined by two-digit Standard Industrial Category Code (SIC) based on Midland's share of regional employment. Service, or nonbasic, employment expected to be generated as a result of the growth in basic employment at Midland, was developed through the use of multipliers. Distribution of basic and nonbasic Midland employment potential is given in table 16-38.

The program's potential impact on employment in the nine-county labor market area, for estimating purposes, is considered to be a direct function of employment opportunity derived by Spindletop Research Service for this study. Impact of the maximum development plan is shown graphically on exhibit 16-15. The increment in job opportunities (table 16-39) was added to the historic normal projection to obtain employment impact. Program impact on population was estimated by:

(1) Projected historic-normal population plus;

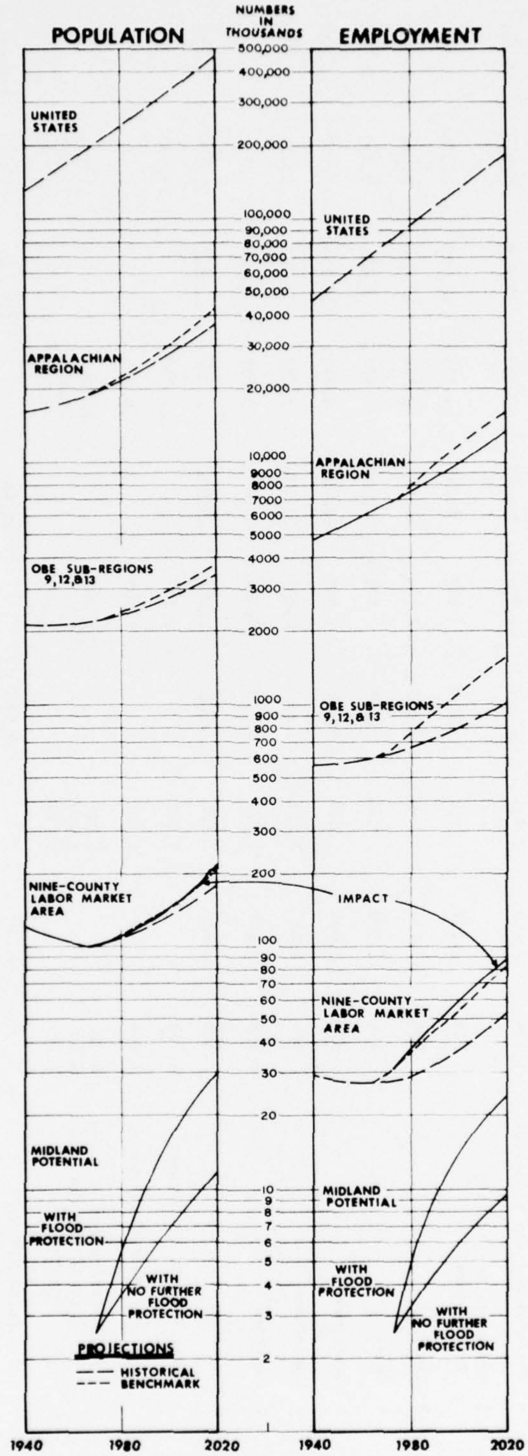
(2) Population/employee ratios for 1980, 2000, and 2020, times historic-projected employment plus employment increment of development plan.

TABLE 16-38

TOTAL EMPLOYMENT POTENTIAL FOR MIDLAND 1980 TO 2020 1/

Employment Sector	SIC Group	1980	1990	2000	2010	2020
Manufacturing	--	1,300	3,200	4,900	6,900	9,700
Furniture	25	195	385	490	550	580
Fabricated Metals	34	260	640	980	1,380	1,940
Machinery	35 and 36	325	800	1,225	2,070	3,300
Transportation Equipment	37	130	255	295	345	390
Other Durable	38 and 39	130	385	685	965	1,455
Food	20	65	160	245	345	485
Printing	27	130	255	390	485	580
Paper	26	0	65	100	140	195
Rubber and Plastics	30	65	255	490	620	775
Recreation	79	610	840	1,050	1,050	1,050
Education	822	420	920	1,320	1,600	1,800
Medical	80	1,000	1,100	1,200	1,300	1,400
Total Basic Employment		3,330	6,060	8,470	10,850	13,950
Transportation, Communication, Utilities	40 to 49	102	172	218	249	291
Trade	50 to 59	458	979	1,564	2,193	3,072
Finance, Insurance & Real Estate	60 to 67	99	219	363	525	749
General Services	70 to 89	310	680	1,113	1,597	2,270
Construction	15 to 17	132	282	452	640	895
Total Government		419	888	1,410	1,976	2,763
Federal	91	100	211	336	470	658
State	92	76	161	255	358	500
Local	93	79	168	266	373	522
General Education	821	164	348	553	775	1,083
Total Nonbasic Employment		1,520	3,220	5,120	7,180	10,040
Total Midland Employment		4,850	9,280	13,590	18,030	23,990

1/ Employment data are cumulative.



POPULATION AND EMPLOYMENT PROJECTIONS

EXHIBIT 16-15

TABLE 16-39

CUMULATIVE EMPLOYMENT AND WAGE POTENTIAL - MIDLAND DEVELOPMENT PLAN

Skill Level	1980 Employees	1980 Wages ($1,000)	1990 Employees	1990 Wages ($1,000)	2000 Employees	2000 Wages ($1,000)	2010 Employees	2010 Wages ($1,000)	2020 Employees	2020 Wages ($1,000)
1 Professional and Technical	1,136	8,012	1,932	16,047	2,731	26,101	3,653	39,449	4,926	59,301
2 Managers, Officials & Proprietors	289	2,227	570	5,099	842	8,539	1,101	12,608	1,434	18,210
3 Clerical	706	3,255	1,404	7,113	2,159	11,893	2,974	17,668	4,062	25,852
4 Sales	214	1,258	451	3,038	708	5,349	962	8,091	1,293	11,933
5 Craftsmen	471	3,634	1,034	9,375	1,583	16,490	2,215	26,155	3,079	40,510
6 Operatives	684	4,447	1,761	11,637	2,676	20,204	3,782	31,968	5,312	49,799
7 Services	1,098	2,619	1,871	4,929	2,604	7,465	3,053	9,436	3,558	11,768
8 Laborers	152	652	257	1,272	287	1,611	290	1,820	326	2,262
Total Primary Employment	4,750		9,280		13,590		18,030		23,990	
Secondary Employment	3,560		6,100		7,990		9,680		11,580	
Total Employment	8,310		15,380		21,580		27,710		35,570	
Locally Hired	6,210		12,300		18,130		23,830		31,300	
Imported	2,100		3,080		3,450		3,880		4,270	
Primary Wages		26,104		58,510		97,652		147,195		219,635
Secondary Wages		17,722		38,460		57,416		79,028		106,015
Total Wages		43,826		96,970		155,068		226,223		325,650
Locally Hired (Regional & National Account)		32,870		77,576		130,257		194,552		286,572
Imported (Regional Account)		10,956		19,394		24,811		31,671		39,078

Colonel John C. H. Lee, Jr.

Wage and salary projections were derived from the distribution of Midland's employment into skill level requirement categories. Distribution of skill level was assumed to be the same as data representing state totals based on Kentucky's 1960 distribution. The ability of the existing labor supply to meet the skill needs of the potential labor force base is illustrated by table 16-40. With exception of the professional skills, there is a substantial excess of available persons in each skill level. National median income data for skill levels were adjusted to reflect the Kentucky average. Resulting wage and salary projections are given in table 16-39, by skill level. Accompanying the employment and wage potential estimated for Midland, non-Midland employment and wage impact, based on residency of Midland employment within the nine-county labor market area, is expected to benefit as illustrated by the secondary assignments of table 16-39. These values were derived from Midland data.

TABLE 16-40

COMPARISON OF SUPPLY AND DEMAND
OF LABOR SKILL LEVELS

Skill Level	Available 1966	Need 1980	Excess or (deficit)
Laborers	950	152	798
Service	2,072	1,098	974
Operatives	3,053	684	2,369
Craftsmen	1,277	471	806
Sales	1,026	214	812
Clerical	1,001	706	295
Manager	711	289	422
Professional	130	1,136	(1,006)
Total	10,220	4,750	5,470

Local hires would normally be expected to be obtained from the ranks of unemployed or underemployed to the extent of the available supply. Those wages and salaries accruing to the unemployed or under-employed are normally credited to both the national and regional accounts as a measure of increased national productivity. However, in consideration of the forces presently at work to reduce unemploy-ment and other programs which will probably be directed to that end in the future, the wages and salaries accruing to the national benefit account have been reduced as depicted in figure 16-17.

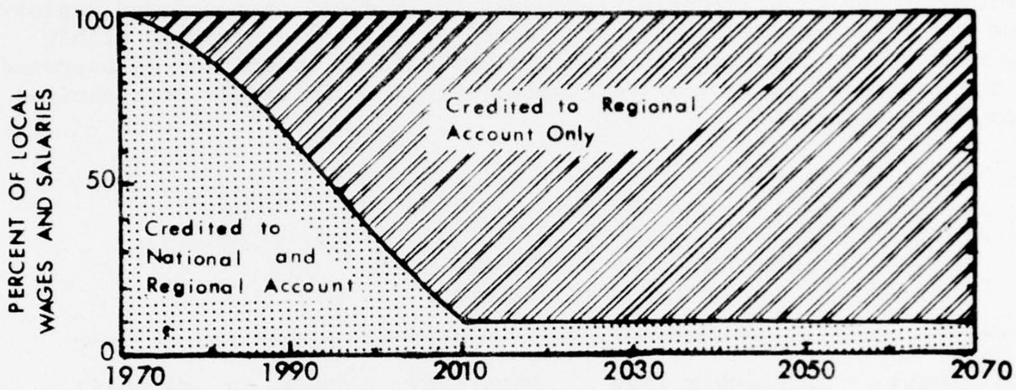


Figure 16-17 Local Wage and Salary Adjustment Curve For National Account.

The regional account is increased to reflect the employees who would be imported from outside the labor-shed. This assumption is conservative since some of the imports may come from the unemployed or underemployed in other parts of the country. Thus, the regional account reflects the wages that are generated by the project and paid to all workers irrespective of where they are located. The wages for each year were discounted to 1970 at 3-1/4 percent interest rate and credited to the regional and national accounts to the extent that they (wages) accrue to unemployed or underemployed.

Table 16-41 presents a summary of the expansion benefits for the development with and without the local flood protection project and also shows the incremental benefits attributable to the project.

TABLE 16-41

SUMMARY OF MIDLAND DEVELOPMENTAL
EXPANSION BENEFITS
(Thousand Dollars)

Item of Benefit	Potential with Flood Protection		Potential without Flood Protection		Net Assignment to Local Protection Project	
	Accumulated Present Worth 1/	Average Annual Equivalent	Accumulated Present Worth 1/	Average Annual Equivalent	Accumulated Present Worth 1/	Average Annual Equivalent
Wages						
Locally Hired						
Regional Account	4,198,531	142,250 2/	1,848,500	62,619 2/	2,350,031	79,631 2/
National Account	994,086	33,678 2/	513,810	17,407 2/	480,276	16,271 2/
Imported						
Regional Account	706,366	23,932 2/	330,070	11,183 2/	376,296	12,749 2/
Total Regional Account		166,182 3/		73,802 3/		92,380 3/
Total National Account		33,678 3/		17,407 3/		16,271 3/

1/ Converted to present worth values by 3-1/4% compound interest factor.
2/ Spread over project life at 3-1/4% interest rate.
3/ Before transfer to table 16-33, benefits were adjusted to exclude normal future growth and operation and maintenance of water resource projects.

Redevelopment Expansion Benefits - The proposed local flood protection project at Midland is located in an area designated as a redevelopment area in accordance with Public Law 87-27. The area unemployment rate for Bath and Rowan Counties, Kentucky, is classified as persistent, and as such the cost of labor used in project construction is credited as redevelopment project benefits under provisions of the law. Detailed analysis of construction costs for similar projects in the Louisville District, Corps of Engineers, indicates labor costs to be about 50 percent of project construction costs (exclusive of lands and damages). Further analysis was made to determine the degrees of skill required in project construction, operation, and maintenance, and what portion of these labor skills could be furnished from locally unemployed or underemployed. The results of these studies are presented as a part of table 16-42.

TABLE 16-42

LABOR SKILL REQUIRED FOR MIDLAND LOCAL PROTECTION PROJECT

Item	Labor Required (percent)	Supplied Locally (percent)	Redevelopment Factor National Account	Redevelopment Factor Regional Account
Construction				
Skilled	56	25	0.14	0.56
Semi-skilled	17	50	0.08	0.17
Unskilled	27	100	0.27	0.27
Total	100		0.49	1.00
Operation and Maintenance				
Skilled	20	25	0.05	0.20
Semi-skilled	40	50	0.20	0.40
Unskilled	40	100	0.40	0.40
Total	100		0.65	1.00

Redevelopment benefits credited to the regional account consist of the average annual equivalent of all wages paid for labor used in construction, operation, and maintenance of the water resource project. Benefits credited to the National account are the wage payments made

to persons who: would otherwise be unemployed and underemployed; live in the redevelopment area within commuting distance of the project; possess the necessary skills required for project construction. Summarized as part of table 16-42 are the skill requirement factors creditable to the regional and national accounts. Derivation of redevelopment benefits utilizing factors presented in table 16-42 is presented in table 16-43.

TABLE 16-43

REDEVELOPMENT BENEFITS FOR MIDLAND
LOCAL PROTECTION PROJECT
($1,000) 1/

			Annual Redevelopment Benefits	
Item	Expenditure	Labor 2/ Costs	National Account 3/	Regional Account 4/
Construction	2,503	1,252	5.9	12.0
Annual Operation and Maintenance	30	21	1.0	6.0
Total Benefits			6.9	18.0

1/ Benefits accrue to first 10 years of first phase construction with zero accumulation 1970 to 1979.

2/ Labor cost is estimated to be 50 percent of construction cost less lands and damages; 70 percent of operation and maintenance expenditures.

3/ Using 3-1/4% interest rate and the appropriate redevelopment factor, future benefits were discounted to reflect a 20-year time horizon for future expenditures.

4/ Discounted where applicable for 3-1/4% interest rate and accelerated growth curve for future expenditures.

20. INTANGIBLE BENEFITS

Intangible benefits are those benefits which, although recognized as having real value in satisfying human needs or desires, are not fully measurable in monetary terms, or are incapable of such expression in formal analysis. Inasmuch as major floods usually occur in the winter months and are occasioned by rapid rises, the dangers to life

and health are compounded. Although no loss of life or epidemic diseases have been recorded as directly attributable to floods in recent years, the danger is ever present. Also of importance is the adverse effect of prolonged periods of inundation on the general welfare. During major floods, such as the occurrences of February 1939 and February 1962, communications are interruped, utilities become inoperative and transportation routes impassable. These breakdowns in communications and service result in delays in evacuation, prevent the rendering of needed assistance, and add to the already difficult problem of rehabilitation.

SECTION VI - ECONOMIC ANALYSIS

21. INDICES OF PERFORMANCE

Element One of the plan - the water control structures - will function as one unit of an integrated water resource development system. Cave Run Reservoir and the USDA structures on Triplett and Salt Lick Creeks constitute the other units of this system. This system will alleviate flooding, have the potential to meet water supply and water quality control needs, provide needed opportunity for outdoor recreation, and create a favorable physical environment for private and public investment and attendant economic expansion which comprises Element Two of the plan. The water control units will operate as a system. However, this economic analysis deals only with local flood protection works (Element One) and a land use and investment plan (Element Two) of a comprehensive developmental plan at Midland. Other units of the water control system, i.e., Cave Run Reservoir and USDA structures, either have been or will be treated in other reports. See Appendix A - Agriculture, Forestry and Conservation for details on USDA recommendations.

Average annual economic costs of the water control structures and of the economic expansion plan at Midland are, respectively, $170,000 and $9,620,000; resulting in a total average annual investment at Midland of $9,790,000. User benefits, i.e., flood damage prevention and land enhancement benefits, resulting from installation of the local protection project amount of $64,000 annually. Redevelopment benefits would increase this estimate to $70,900 annually. A traditional benefit-cost analysis based upon this annual benefit and an annual cost of $170,000 yields a ratio of 0.41 to 1.0. Therefore, construction of the local protection project cannot be justified by user benefits alone.

This investigation focuses on economic development of this sub-area of the Appalachian Region. A basic objective of works proposed under the Appalachian program is to expand economic opportunities within the region. Expanding employment opportunities and thereby increasing the annual wage bill is a primary method of achieving this objective. In this regard a ratio of increased wage payments to costs affords a relative index of performance of the complete developmental plan. Increased wage payments resulting from the selected plan are wages resulting from employment on construction of the local protection works plus wages from employment arising from expanded economic activity occasioned by the complete development plan. Annual wages from these sources total $92,380,000. Based on these annual wages and the total annual cost of the selected plan ($9,790,000) the index of performance is 9.4.

22. COST ALLOCATION

Cost allocation studies were not required in this investigation since no multipurpose works are being evaluated.

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SECTION VII - COST SHARING

23. APPLICABLE LEGISLATION

With respect to the flood control features of the plan, local interest requirements would be in accord with the Federal policy given in Section 201 of the 1958 Flood Control Act (Public Law 85-500), which provides that usual requirements of local cooperation are those specified in Section 3 of the 1936 Flood Control Act, as follows:

"That hereafter no money appropriated under authority of this Act shall be expended on the construction of any project until States, political subdivisions thereof, or other responsible local agencies have given assurances satisfactory to the Secretary of War (Army) that they will (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, except as otherwise provided herein; (b) hold and save the United States free from damages due to the construction works; (c) maintain and operate all the works after completion in accordance with regulation prescribed by the Secretary of War (Army)...." In addition to these usual local requirements, non-Federal interests would also be required to (d) prevent obstruction or encroachment on flood carrying capacities of the channels; (e) assume title to all Federal interests in lands, easements and rights-of-way acquired by the United States in lieu of non-Federal acquisition as each phase becomes operational. With respect to the developmental plans (Element Two), there is no Federal legislation dealing specifically with division of responsibilities in this regard.

24. APPORTIONMENT OF COSTS

Apportionment of costs between Federal and non-Federal interests is made according to the following criteria and summarized in table 16-44.

Non-Federal interests have been apportioned the costs of all lands and rights-of-way required for construction of the local protection projects and all costs associated with their operation and maintenance. Since an expanded levee section is required to accommodate U.S. Highway 60 the net difference in costs between this expanded section and a standard levee section has been apportioned to non-Federal interests.

No windfall benefits of unconscionable magnitude are expected to accrue. Therefore, no cost sharing is required relative to the enhancement aspects of the levee plan.

TABLE 16-44

APPORTIONMENT OF COSTS BETWEEN FEDERAL
AND NON-FEDERAL INTERESTS

Items	Federal	Non-Federal	Total
		FIRST COST 1/	
Water Resource Plan			
Phase I (1980)	$2,364,000	$276,000	$2,640,000
Phase II (2000)	3,834,000	306,000	4,140,000
Phase III (2020)	1,366,000	84,000	1,450,000
Totals	$7,564,000	$666,000	$8,230,000
		ANNUAL CHARGES 2/	
Phase I	$ 58,100	$ 31,900	$ 90,000
Phase II	49,700	18,300	68,000
Phase III	9,500	2,500	12,000
Totals	$ 117,300	$ 52,700	$ 170,000

1/ July 1968 Prices
2/ AAE Charges During 100-year Project Life.

25. STATE AND LOCAL ASSURANCES*/

Prior to initiation of construction of the flood control plan, non-Federal interests must furnish assurances satisfactory to the Secretary of the Army that they will:

(1) Provide without cost to the United States all lands, easements, rights-of-way, and alterations and relocations necessary for the construction and operation of the plan.;

(2) Hold and save the United States free from damages due to the construction works;

(3) Operate and maintain the completed works in accordance with regulations prescribed by the Secretary of the Army;

(4) Prevent encroachments in ponding areas and channels;

(5) Assume title to Federal interests (in lieu of acquisition) in project units as construction of each phase is completed.

(6) Hold and save the United States free from all water rights

*/ See paragraph 29 for a discussion of necessary assurances.

claims resulting from implementation and operation of the plan; and

(7) Satisfy the Secretary of the Army that there is reasonable assurance that programs and measures necessary for the accomplishment of the economic development objectives of the developmental plan will be instituted and supported in such manner as to secure the effective realization of the plan set forth in this report.

Satisfactory letters of assurances have been received from the Commonwealth of Kentucky and the Gateway Area Development Council. These letters are included herein as exhibits 16-16, and 16-17, respectively.

LOUIE B. NUNN
GOVERNOR

JAMES S. SHROPSHIRE
COMMISSIONER
JEWELL GRAHAM
DIRECTOR
TELEPHONE 564-3980

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
FRANKFORT, KENTUCKY 40601

August 29, 1969

Colonel John C. H. Lee, Jr.
Corps of Engineers
Office of Appalachian Studies
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee:

I have reviewed the draft report on the Midland Local Protection Project in Bath and Rowan, Kentucky, and have found the developmental plan presented therein unique in its concepts and objectives.

We note that implementation of this project would require assurances of participation by non-Federal interests in the construction and maintenance of the works. It is also indicated that such non-Federal interests would be required to accept the civil responsibility for the works, police the project, and assure measures necessary for accomplishing the economic development objectives of the plan.

There is no precedent for the Commonwealth having assumed the above noted responsibilities in other local flood protection projects. Local participation in such projects has been by existing local governmental entities or by local groups organized and endowed with the necessary authority to participate in a specific project. Acceptance by the Commonwealth of the non-Federal responsibilities for the Midland Local Protection Project would be subject to criticism by communities presently supporting such projects and would imply a similar responsibility by the Commonwealth in future local flood protection projects.

The Commonwealth is aware that the effective realization of the plan set forth in the report would be of significant benefit to the area. However, it is considered advisable that non-Federal participation in the project be through a proper local governmental entity established for that purpose.

"EVERY KENTUCKIAN COUNTS"

Colonel Lee
August 29, 1969
Page 2

The Gateway Area Development District, Inc., has indicated its willingness to provide all of the assurances required of non-Federal interests in implementation of the project upon being legally empowered to discharge the responsibilities.

The Commonwealth of Kentucky will actively support measures to establish The Gateway Area Development District, Inc., or other proper organization as a legal entity for the purpose of discharging the local responsibilities associated with the Midland Local Protection Project.

Also, the Commonwealth will support the programs and measures necessary for the accomplishment of the economic development objectives of the developmental plan so as to secure the most effective realization of the plan described in the report.

Sincerely yours,

Jewell Graham

Jewell Graham, Director
Division of Water

JG:SMT:sa

Sheet 2 of 2
Exhibit 16-16

GATEWAY AREA DEVELOPMENT DISTRICT, INC.

P. O. BOX 107

OWINGSVILLE, KENTUCKY 40360

August 25, 1969

Colonel John C. H. Lee, Jr.
Director, Office of Appalachian Studies
Corps of Engineers
Department of the Army
P. O. Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee:

As President of the Gateway Area Development District, incorporated as a non-profit corporate entity serving Bath, Rowan, Menifee, Morgan, and Montgomery Counties, I have completed my review of the draft report on the Midland Local Protection Project in Bath and Rowan Counties, Kentucky and feel that the project, as now formulated, will be of significant benefit to the Gateway Development District in releasing the development potential of the Midland Plan. Let me further assure you that the Midland project has been established as Gateway's top priority program.

I understand that implementation of the Midland Local Protection Project, as currently proposed, would require participation by the Gateway Development District. I further understand, however, that a non-public agency cannot assume all of the commitments necessary to assure the federal government that lands, rights, and financial commitments will be met in accordance with project plans. Acting on behalf of the Gateway Development District Board, I have formally requested the State of Kentucky to:

(1) Assume the guarantee of non-federal commitments for the project with the understanding that the Gateway Area Development District, acting on behalf of the municipality and fiscal courts in question, will assume actual responsibility for providing and guaranteeing the commitments mentioned in this letter.

(2) At such time as there is appropriate local authority to accept the full legal responsibility as dictated by the U. S. Army Corps of Engineers, the State will transfer full responsibility to the local authority.

Therefore, acting as the designated representative of the Gateway Area Development District, I hereby indicate the intent of the Gateway Development District, in concert with the State of Kentucky, to:

(a) Provide without cost to the United States all lands, easements, rights-of-way, and alterations and relocations necessary for the construction and operation of the plan at an estimated cost of $666,000;

(b) Hold and save the United States free from damages due to the construction works;

(c) Operate and maintain the completed works in accordance with regulations prescribed by the Secretary of the Army at an estimated annual cost of $84,700;

(d) Prevent encroachments in ponding areas and channels;

(e) Assume title to Federal interests (in lieu of acquisition) in project units as construction of each phase is completed;

(f) Hold and save the United States free from all water rights claims resulting from implementation and operation of the plan; and

(g) Satisfy the Secretary of the Army that there is reasonable assurance that programs and measures necessary for the accomplishment of the economic development objectives of the developmental plan will be instituted and supported in such manner as to secure the effective realization of the plan set forth in the report.

With regard to the above, since at this time it appears that all our available capital resources will be needed for construction of roads, sewers and other public works and preparation of commercial and industrial sites, we hereby request that all non-Federal first costs for Phase I of the plan be initially funded by the Federal Government, including provisions of (a) above at an estimated cost of $276,000 and (c) above at an estimated annual cost of $34,700. We do intend, however, to repay said costs plus interest during construction within 60 years from the date that each project unit of Phase I becomes operational, at a repayment rate that is satisfactory to the Secretary of the Army. I would hope that no interest will accrue during the first ten years after each unit cf Phase I becomes operational.

At such time as detailed planning is undertaken for the Midland projects, the Gateway Development District, acting for itself or on behalf of any interested political subdivision, and in cooperation with the State of Kentucky, reserves the right to recommend to and

negotiate with the Corps of Engineers concerning modifications or additional project purposes which may be deemed mutually desirable.

Thank you.

Very truly yours,

Caswell P. Lane

Caswell P. Lane
President

CPL:par

SECTION VIII - COORDINATION IN PLANNING

26. FEDERAL AGENCIES

In the course of preparing this Chapter, contacts and liaison were made with interested Federal agencies. Federal agencies, which have been contacted or that have contributed to the preparation of the plan, are listed below.

The Appalachian Regional Commission (ARC) funded a study to determine the economic potential of a regional urban center at Midland and to determine alternative institutional organizations necessary to administer a developmental program of that magnitude.

The Federal Water Pollution Control Administration, Department of Interior, has made a cursory investigation to determine the need for water quality control in the Midland area. Their investigation indicates that 60 cfs will be needed by 2020. This flow would be supplied by Cave Run Reservoir.

The Economic Research Service, the Forest Service, and the Soil Conservation Service (SCS), all U.S. Department of Agriculture agencies, have investigated solutions to water and land resource problems preventing or hindering economic growth and development in the Triplett Creek watershed. The investigation and report was a joint effort of these agencies and was made under authority of Section 206 of the Appalachian Regional Development Act of 1965. Nineteen floodwater retarding structures were considered in the study. The work plan for Salt Lick Creek watershed has been completed. This plan includes five floodwater retarding structures, one multiple-purpose structure, channel improvements and watershed treatment. These structures would supplement local flood protection works at and in the vicinity of Salt Lick as considered herein. The State Conservationist (SCS) stated in a letter dated 8 August 1968 that works as defined herein do not appear to adversely affect any projects they have or expect to have in the area.

The Bureau of Outdoor Recreation, Department of the Interior, stated in their letter of 20 August 1968 that because of personnel limitations and the time schedule no comments could be furnished at the time.

The Bureau of Sport Fisheries and Wildlife, Department of the Interior, stated in their letter of 16 October 1968 that, aside from the possible effects of a levee section on a proposed fish hatchery immediately below Cave Run dam, they do not believe the local protection project would significantly effect the area's fish and wildlife resources.

27. NON-FEDERAL AGENCIES

The Area Development Office of the Commonwealth of Kentucky; the Institute for Environmental Services, University of Kentucky; the Spindletop Research Center; the Midland Industrial Foundation; and the Gateway Area Development Council have all been working toward formulating a development plan for Midland. Contact with these organizations has been maintained throughout the course of this investigation. Also, the Kentucky Department of Highways has been contacted concerning the location and grade of Interstate 64 in the study area. The Kentucky Department of Fish and Wildlife Resources has concurred with the U.S. Bureau of Sport Fisheries and Wildlife views.

28. PUBLIC HEARINGS

(At this time the scheduling of a public hearing on the over-all plan of development for Midland has been delayed, pending completion of control measures necessary to assure the success of the planned development and preclude unconscionable profiteering or adverse development of the area. This hearing is currently expected to be held in late June or early July 1969 after satisfactory completion of regulatory measures).

29. PROCEDURES FOR PLAN IMPLEMENTATION

The successful consummation of the proposed plan of development of the Midland area will be dependent upon the construction of the flood protection works by the Corps of Engineers and vigorous, aggressive action by the local development organization, augmented and supplemented by the appropriate Commonwealth agencies. Close coordination is essential, especially in regard to any necessary adjustment of the local flood protection construction schedule to dovetail with attainment of development levels requiring departures from the schedule proposed to provide protection to specific areas as their development is initiated.

Since the area has lagged behind in its development, there is not the fiscal base which will, at this time, permit the local interests to pay or contribute in kind the non-Federal first costs of Phase I of Element One of the plan (namely; lands, easements and rights-of-way). Available capital will be fully obligated to undertake the capital outlays necessary for construction of public works and the preparation of industrial sites. In order that growth and development may occur in the area, which will not happen without significant local participation and leadership, it is concluded that all non-Federal first costs for Phase I of the plan should be initially funded by the Federal Government, if so requested by non-Federal interests. All non-Federal first costs initially assumed by the United States for acquisition, performance, or assumption of non-Federal responsibilities,

plus interest during construction, should be repaid by such non-Federal interests with interest compounded annually, within 60 years from the date that each item for which the acquisition and performance is accomplished becomes operational, at a repayment rate that is satisfactory to the Secretary of the Army. During the first ten years after each project unit of Phase I becomes operational no interest should accrue and repayment, although it may be made, should not be required. The interest rate should be determined in accordance with the formula set forth in the Water Supply Act of 1958, P.L. 85-500, as amended. It is assumed that before initiation of Phase II of the plan the area's tax structure will be improved to the point where it can provide the required non-Federal funds.

The Corps of Engineers would be responsible for acquisition and other local interest requirements for Phase I only. Also, as the construction agency, the Corps of Engineers would be responsible for the design and construction of the local flood protection works of all phases of the project.

The Gateway Area Development Council, or its successor organization as established by laws of the Commonwealth of Kentucky, would be responsible for furnishing required assurances of the assumption and discharge of the non-Federal responsibilities connected with the local flood protection project.

Realization of the plan's potential benefits are dependent, to a large degree, on the initiative and vigor of non-Federal interests in attracting industry to the area. Therefore, prior to commencement of construction of any unit of the plan, the Secretary of the Army, should determine to his satisfaction that there is reasonable assurance that programs and measures necessary to accomplish the economic development objectives of the over-all plan, particularly as set forth in Element 2 of the plan, will be instituted in such manner as to secure the effective realization of the plan set forth in this report. The Secretary's determination should be based upon:

(1) Existence of a competent and appropriate public body, quasi-public body, or private non-profit development corporation, which is empowered to achieve the economic development objectives of the plan and to furnish assurances of non-Federal participation as specified above and as may not be furnished by other non-Federal interests;

(2) Receipt of all assurances of non-Federal participation as specified above;

(3) Implementation of those programs and measures necessary to achieve the economic development objectives of the plan, which programs and measures shall assure that the necessary lands shall be available and that profiteering in the private sector shall be precluded.

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SECTION IX - CONCLUSIONS

30. CONCLUSIONS

The Midland local flood protection project, as presented herein, is required for realization of the full developmental potential at Midland, and to sustain and expand the economic improvement of this economically-depressed region.

In the course of studies made for preparation of this report it became quite evident that implementation of a plan for development of a regional industrial and urban center at Midland would be the most feasible measure to close the economic gap between the nine-county study area and the nation. Development concepts exhibited herein are responsive to a basic objective of the Appalachian Regional Development Act of 1965 (PL 89-4, Eighty-ninth Congress, 1st Session); that is, to expand economic opportunities within the Appalachian Region thereby enhancing the welfare of its people. With this objective in mind the developmental plan set out in this report has been formulated to take advantage of Midland's full development potential at least possible costs. It has, therefore, been concluded that local flood protection works in the Midland area should be adopted and authorized for construction in general accordance with the plan presented in this report; provided that prior to initiation of construction, responsible non-Federal interests furnish satisfactory assurances that local requirements as set out in Section VII of this Chapter will be met.

Since the area has lagged behind in its development, there is not the fiscal base which will, at this time, permit the local interests to pay or contribute in kind the non-Federal first costs of Phase I of element one of the plan; -- namely, lands, easements and rights-of-way -- and also to undertake the capital outlays necessary for the preparation of industrial sites. In order that growth and development may occur in the area, which will not happen without significant local participation and leadership, it is concluded that all non-Federal first costs for Phase I of the plan should be initially funded by the Federal Government if so requested by non-Federal interests. All non-Federal first costs initially assumed by the United States for acquisition, performance, or assumption of non-Federal responsibilities plus interest during construction should be repaid by such non-Federal interests with interest compounded annually, within 60 years from the date that each item for which the acquisition and performance is accomplished becomes operational, at a repayment rate that is satisfactory to the Secretary of the Army. During the first ten years after each project unit becomes operational no interest should accrue and repayment, although it may be made, should not be required. The interest rate should be determined in accordance with the formula set forth in the Water Supply Act of 1958, P.L. 85-500, as amended. It is assumed that before

initiation of Phase II of the plan the area's tax structure will be improved to the point where it can provide the required non-Federal funds.

Realization of the plan's potential benefits are dependent to a large degree, on the initiative and vigor of non-Federal interests in attracting industry to the area. Therefore, prior to commencement of construction of any unit of the plan, the Secretary of the Army, should determine to his satisfaction that there is reasonable assurance that programs and measures necessary to accomplish the economic development objectives of the over-all plan, particularly as set forth in Element 2 of the plan, will be instituted in such manner as to secure the effective realization of the plan set forth in this report. The Secretary's determination should be based upon:

(1) Existance of a competent and appropriate public body, quasi-public body, or private non-profit development corporation, which is empowered to achieve the economic development objectives of the plan and to furnish assurances of non-Federal participation as specified above and as may not be furnished by other non-Federal interests;

(2) Receipt of all assurances of non-Federal participation as specified above;

(3) Implementation of those programs and measures necessary to achieve the economic development objectives of the plan, which programs and measures shall assure that the necessary lands shall be available and that profiteering in the private sector shall be precluded.